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SPECIFICATION

STAIRCASE

TECHNICAL FIELD

The present invention relates to a staircase.

BACKGROUND ART

Conventionally, there have been various forms to support the treads of a staircase. In the case of a staircase made of wood or steel, the treads are generally supported by stringers (including open stringers in the present specification). The stringers, which must support a heavy load from the treads, are composed of large, thick members such as channel steel or I-shaped steel in the case of a steel staircase, for example.

However, in conventional staircases, the heaviness of the stringers requires a lot of work in carrying and constructing. Furthermore, the stringers differ in length and shape, depending on the installing requirements including the number of steps in the staircase and the slope of the staircase, which makes it difficult to manufacture stringers efficiently.

Large and heavy members such as channel steel or I-shaped steel are used not only for staircase stringers but also for other architectural structural members; however, using such members at a noticeable position of a constructing structure creates an oppressive impression because of their heaviness, and also is poor in design.

In this context, the published examined utility model

application No. 4-21389 discloses a staircase with a simplified appearance, which disposes the treads inside between a pair of right and left side frames formed in a truss design. This staircase is composed of a pair of right and left side frames formed in a truss design; linking members for linking the lower chord members on both side frames; handrails which are located above the side frames and linked to them via linking members and which are arranged in parallel along the upper chord members of the side frames; and treads laid inside between both side frames. And in order to prevent lateral buckling of the staircase, each end part of the upper chord members of the side frames and each end part of the handrails are bent outwards so as to have bent parts.

However, in this staircase, the handrails serve as structural members to maintain the strength of the staircase; the treads are supported by the lower chord members of the side frames; and the upper chord members of the side frames are located above the treads, that is, at the height of the handrails. Therefore, this staircase is not suitable as a staircase dispensable with handrails. For example, if this staircase is constructed along a wall face, the side frame is arranged right beside the wall face and also above the treads, which rather spoils the appearance of the staircase. Additionally, the handrails of the staircase which could be designed comparatively freely must serve as structural members, thereby causing restrictions in design.

Also in the aforementioned staircase, the upper chord

members and the handrails are provided with bent parts to improve the strength; however, the handrails are arranged along the upper chord members of the right and left side frames, making it impossible to link the upper cord members with each other, thereby limiting any improved strength of the staircase as a whole. In addition, forming the bent parts requires bending work, which inevitably is troublesome.

Furthermore, it is difficult to manufacture the bent parts efficiently because they must be processed in accordance with different installing requirements such as the number of steps and the slope of the staircase.

Therefore, the present invention has an object of providing a staircase having a lightweight structure and giving a light impression, and another object of providing a staircase having high strength and high efficiency in productivity and workability.

DISCLOSURE OF THE INVENTION

In order to solve such problems, the invention according to claim 1 is a staircase composed of: a pair of right and left stringers composed of a truss structural members; and treads, wherein the truss structural members are each composed of: an upper chord member and a lower chord member which are inclined with the slope of the staircase; and a plurality of lattice members for linking the upper chord member and the lower chord member.

According to this staircase, the stringers for supporting

the treads are composed of truss structural members, which can make the staircase have a lightweight structure. In addition, unlike staircases made of heavy members such as channel steel or I-shaped steel, staircase with a sense of lightness in weight and openness can be constructed, without giving a sense of oppression even when it is installed indoors.

The invention according to Claim 2 is the staircase according to Claim 1, wherein the truss structural members are linked to each other by treads.

According to this staircase, since left and right truss structural members are linked to each other by the treads, this improves torsional rigidity and flexure rigidity in the side-to-side direction of the entire staircase, whereby twisting and rolling of the staircase when people go up and down the staircase can be greatly reduced.

The invention according to Claim 3 is the staircase according to Claim 1, wherein the plurality of lattice members include a plurality of horizontal lattice members disposed horizontally for each riser, and the treads are supported by the horizontal lattice members.

According to this staircase, when the staircase is seen from the side, the tread is positioned between the upper chord member and the lower chord member, so that a simplified appearance is realized.

The invention according to claim 4 is the staircase according to claim 1, wherein the truss structural members are linked to each other via a plurality of linking members which

are laid horizontally at each riser height, and the treads are fixedly supported on the linking members.

According to this staircase, the light and left truss structural members are linked to each other via the linking members, and as a result, the torsional rigidity of the entire staircase and the flexural rigidity the side-to-side direction are improved, which greatly reduces the development of twisting or rolling of the staircase when people are going up and down the staircase.

The invention according to Claim 5 is the staircase according to Claim 4, wherein the linking members adjacent to each other in the height direction are linked to each other.

According to this staircase, since the plurality of linking members are integrated by being linked to each other in the height direction, when a load in the side-to-side direction is applied to one of the treads (linking members), this load is divided among other linking members. Therefore, for example, the development of twisting or rolling when people go up and down the staircase is significantly reduced. Furthermore, the linking members adjacent to each other in the height direction are preferably linked to each other by a flat plate member with high rigidity in the side-to-side direction. The use of the flat plate member more efficiently improves the rigidity in the side-to-side direction of the staircase.

The invention according to claim 6 is the staircase according to any one of claims 1 through 5, wherein the upper chord member and the lower chord member are each provided with

node members, and the lattice members are joined with the node members.

According to this staircase, the staircase can be constructed just by joining the lattice members with the node members installed in the upper chord members and the lower chord members. It is preferable that the node members are installed on the bottom faces of the upper chord members or the top faces of the lower chord members. This enables the node members to be installed regardless of the inner shapes of the upper chord members and the lower chord members, so that the inner shapes of the upper chord members and the lower chord members can be determined as desired.

The invention according to claim 7 is the staircase according to claim 6, wherein the node members are column-shaped and each have linking grooves formed on an outer surface thereof; the lattice members each have linking end parts formed on both ends; and the linking groove and the linking end parts have notches to be engaged with each other, and nodes are formed by press fitting the linking end parts into the linking grooves.

According to this staircase, the linking end parts formed on both ends of the lattice members can be press fit into the linking grooves formed on the outer faces of the node members to join the lattice members and the node members, which facilitates the constructing of the staircase. Furthermore, the notches formed on each of the linking grooves and the linking end parts are engaged with each other, which prevents the lattice members from moving in the axial direction.

The invention according to Claim 8 is the staircase according to Claim 6, wherein at least either the upper chord members or the lower chord members are continued in the direction of the staircase inclination and formed of members having groove parts opened to the lattice member side, and node members are attached inside the groove parts.

According to this staircase, either the upper chord members or the lower chord members are continued in the staircase direction and the node members are attached inside the upper chord members or the lower chord members, so that a simplified appearance can be obtained. Although the node members are attached inside the upper chord members or the lower chord members, the bottom faces of the upper chord members or the top faces of the lower chord members are opened, so that the lattice members can be linked to the node members. Furthermore, the members can be attached with lid members for closing the openings. Thereby, since the openings of the members forming the upper chord members and the lower chord members are closed by lid members, dust accumulation inside the members is prevented and the appearance is also improved.

The invention according to claim 9 is the staircase according to any one of claims 1 through 5, wherein the truss structural members are each composed of node members each disposed at a node point; and frame members for linking adjacent node members.

According to this staircase, the truss structural members are composed by linking a plurality of frame members having

the same length as the distance between adjacent node points, which facilitates the control of the length of the truss structural members. Since the upper chord members and the lower chord members are also formed by linking a plurality of frame members, their whole length can be controlled just by changing the length of the frame members to be linked (changing the riser height and the depth of the treads) or the number of steps. When the plane shape of a staircase is modified like in a spiral staircase, all that must be done is to change the axial direction of the frame members adjacent in the longitudinal direction of the truss structural members so as to join the frame members with the node members. Thus, even a curved staircase can use the same frame members as a straight staircase, which provides high production efficiency.

The invention according to claim 10 is the staircase according to claim 9, wherein the node members are column-shaped and each have linking grooves on an outer surface thereof; the frame members each have linking end parts on both ends; and the linking grooves and the linking end parts have notches to be engaged with each other, and nodes are formed by press fitting the linking end parts into the linking grooves.

According to this staircase, the linking end parts formed on both ends of the frame members can be press fit into the linking grooves formed on the outer faces of the node members to join the frame members and the node members, which facilitates the constructing of the staircase. Furthermore, the notches formed on each of the linking grooves and the linking end parts

are engaged with each other, which prevents the frame members from moving in the axial direction.

The invention according to claim 11 is the staircase according to claim 9 further comprising a reinforcing member arranged along at least one of the upper chord member and the lower chord member, the reinforcing member being fixed with at least to three of the node members.

According to this staircase, in at least one of the upper chord member and the lower chord member, the plurality of node members are integrated via the reinforcing member, so that flexure rigidity in the out-of-plane direction of the truss structural members is improved, resulting in deformation reduction in the out-of-plane direction. This greatly reduces the rolling of the staircase caused by load affecting the side-to-side direction of the staircase. As a result, the members to link the right and left truss structural members can be omitted or made lighter weight, thereby providing a simplified appearance. Designing the reinforcing member flat-shaped can facilitate its production and installment. Shaping the reinforcing member like the letter L or a groove can provide a simple design because it covers the frame members composing the upper chord members or the lower chord members, and also improves vertical rigidity.

The invention according to Claim 12 is the staircase according to any one of Claims 1 through 5, wherein at least either between the right and left upper chord members or between the right and left lower chord members, a plate member is

attached.

According to this staircase, the right and left truss structural members are integrated by the plate member, and shearing deformation of the plane formed by the two upper chord members or lower chord members is reduced, so that the development of twisting or rolling of the truss structural members when people go up and down the staircase is greatly reduced.

The invention according to Claim 13 is the staircase according to any one of Claims 1 through 5, further comprising handrails positioned above the side end parts of the treads, and balusters that have lower ends joined with the truss structural members and support the handrails.

This staircase is provided with handrails above the side end parts of the treads. By bending the lower portions of the balusters supporting the handrails orthogonally to the handrails, rigidity against a load that pushes down the handrail sideward is increased.

The invention according to Claim 14 is a staircase comprising a pair of right and left truss structural members which are inclined with the slope of the staircase and a plurality of treads disposed between the truss structural members, wherein each truss structural member is composed of an upper chord member having a plurality of column-shaped upper node members provided in series in the direction of the staircase inclination, a lower chord member having a plurality of column-shaped lower node members provided in series in the direction of the staircase

inclination, and lattice members that link the upper chord member and the lower chord member to each other, each upper node member and each lower node member are disposed so that the axes thereof are orthogonal to the truss plane of the truss structural member, and on the outer circumferential faces thereof, a plurality of linking grooves are formed along the axes, and the lattice member has flat-shaped linking end parts that can fit into the linking grooves on both ends, one of the linking end parts is fitted into the linking groove of the upper node member, the other one of the linking end parts is fitted into the linking groove of the lower node member, and the ends of each tread are fixed to the side end face of the upper node member and the side end face of the lower node member.

As compared with the conventional staircases composed of heavy members made of channel steel or I-shaped steel, the above-described staircase is structured so that the treads are supported by truss structural members that have lightweight structures and look light in weight, thereby providing a sense of openness and creating no sense of oppression even if the staircase is installed indoors. In addition, the staircase of the invention is structured so that the side end parts of the treads are fixed to the side end faces of the upper node members and the side end faces of the lower node members, whereby the side end faces of the treads are positioned within the side faces of the truss structural members, thereby providing a very simplified appearance.

Furthermore, the upper chord member and the lower chord

member of each truss structural member are linked to each other by the treads. Namely, since the upper chord member and the lower chord member are securely integrated by the lattice members in addition to the treads, the rigidity of each truss structural member is very high. Furthermore, as a result, the upper node members and the lower node members are linked to each other between the right and left truss structural members by the treads, so that displacement and deformation in the out-of-plane direction of the truss planes are restricted by each other. Namely, since the upper chord members are linked to each other and the lower chord members are linked to each other by the treads between the right and left truss structural members and shearing deformation of the plane formed by the right and left upper chord members and the plane formed by the right and left lower chord members are restrained, respectively, as a result, the development of twisting and rolling when people go up and down the staircase is greatly reduced.

The joining between the lattice members and the node members is carried out only by fitting the linking end parts of the lattice members that have been processed so as to be fitted into the linking grooves formed on the outer circumferential face of the node members, without requiring welding or special tools, thereby providing high workability. In addition, since the node members are disposed so that the axes thereof are orthogonal to the truss planes of the truss structural members, the axes of the node members and the axes of the lattice members are always orthogonal to each other

regardless of the slope of the staircase. Namely, regardless of the slope of the staircase, the linking end parts of the lattice members are formed in the direction orthogonal to the axes of the lattice members, thereby enabling mass production and providing high productivity. Since the axes of the node members are orthogonal to the truss planes, the truss structural members have a strong axis direction in the out-plane direction (side-to-side direction of the staircase) and have high strength against an external force or deformation from the out-of-plane direction.

The invention according to Claim 15 is the staircase according to Claim 14, wherein the upper chord members have upper frame members provided between the upper node members adjacent to each other in the direction of the staircase inclination, and the upper frame members have, on their both ends, flat-shaped linking end parts that can be fitted into the linking grooves of the upper node members, and the linking end parts are fitted into the linking grooves of the upper node members.

According to this staircase, the lengths of the upper chord members can be easily adjusted. Namely, since the upper chord member is constructed by providing a plurality of upper frame members in series in the direction of the staircase inclination and linking the upper frame members adjacent to each other in the direction of the staircase inclination to each other by the upper node members, the length of the upper chord member can be adjusted only by increasing or reducing

the number of upper frame members to be linked to each other.

Furthermore, the joining between the upper frame members and the upper node members is carried out only by fitting the linking end parts of the upper frame members which have been processed so as to be fitted in the linking grooves, without requiring welding or special tools, thereby providing high workability. In addition, since the upper node members are disposed so that the axes thereof are orthogonal to the truss planes of the truss structural members, so that the axes of the upper node members and the axes of the upper frame members are always orthogonal to each other regardless of the slope of the staircase. Namely, regardless of the slope of the staircase, the upper frame members are formed so that the linking end parts thereof are orthogonal to the axes of the upper frame members, and this structure can be commonly used for staircases with various slopes and provides high productivity.

The invention according to Claim 16 is the staircase according to Claim 14, wherein the lower chord members have lower frame members disposed between the lower node members adjacent to each other in the direction of the staircase inclination, and the lower frame members have, on their both ends, flat-shaped linking end parts that can be fitted into the linking grooves of the lower node members, and the linking end parts have been fitted into the linking grooves of the lower node members.

According to this staircase, the lengths of the lower chord members can be easily adjusted. Namely, since the lower

chord member is constructed by providing lower frame members in series in the direction of the staircase inclination and linking the lower frame members adjacent to each other in the direction of the staircase inclination by the lower node members, the length of the lower chord member can be adjusted only by increasing or reducing the number of lower frame members to be linked to each other.

Furthermore, the joining between the lower frame members and the lower node members is carried out only by fitting the linking end parts of the lower frame members that have been processed so as to be fitted into linking grooves formed on the side faces of the lower node members, without requiring welding or special tools, thereby providing high workability. In addition, since the lower node members are disposed so that the axes thereof are orthogonal to the truss planes of the truss structural members, the axes of the lower node members and the axes of the lower frame members are always orthogonal to each other regardless of the slope of the staircase. Namely, the lower frame members are formed so that their linking end parts are orthogonal to the axes of these lower frame members, this structure can be commonly used for staircases with various slopes and provides high productivity.

The invention according to Claim 17 is the staircase according to Claim 14, wherein the upper chord member has an upper through member having a length from the upper end to the lower end of the upper chord member, and the upper through member is attached to the side end faces of the upper node members.

According to this staircase, the upper chord member has an upper through member and the upper through member is attached to the side end faces of the plurality of upper node members, thereby reinforcing the strength in the weak axis direction of the truss structural member. Therefore, the truss structural member becomes high in bending rigidity in both the side-to-side direction and the vertical direction, and the development of rolling and flexure when people go up and down is greatly reduced.

The invention according to Claim 18 is the staircase according to Claim 14, wherein the lower chord member has a lower through member having a length from the upper end to the lower end of the lower chord member, and the lower through member is attached to the side end faces of the lower node members.

According to this staircase, since the lower chord member has a lower through member and the lower chord member is attached to the side end faces of the plurality of lower node members, it thereby reinforces the strength in the weak axis direction of the truss structural member. Therefore, the truss structural members become high in bending rigidity in both the side-to-side direction and the vertical direction, and the development of rolling and flexure when people go up and down the staircase is greatly reduced.

The invention according to Claim 19 is the staircase according to Claim 14, wherein the upper node members and the lower node members are positioned at the same heights, and tread receiving members are fixed to the side end faces of the upper node members and the side end faces of the lower node members,

and the treads are fixed to the tread receiving members.

According to this staircase, the work for attaching the treads becomes easy. Furthermore, by employing the method in which the treads are attached via the tread receiving members, it is possible to cope with the case where the upper node members and the lower node members are not positioned at the same heights only by changing the shape or the attachment position of the tread receiving member. Furthermore, the top faces of the treads become horizontal without fail only by attaching the treads along the upper node members and the lower node members, and this makes the work for attaching the treads easy.

The invention according to Claim 20 is the staircase according to any one of Claims 14 through 19, further comprising handrails positioned above the side end parts of the treads, and balusters the lower ends of which are joined to the truss structural member, and supporting the handrails.

This staircase has handrails above the side end parts of the treads. Furthermore, by curving the lower parts of the balusters supporting the handrails in the directions orthogonal to the handrails, the resistance against loads that press down the handrails sideward is increased.

The invention according to claim 21 is a staircase in which treads are supported by a space truss structural member inclined with the slope of the staircase, wherein the space truss structural member is formed by linking a plurality of upper chord members linked to each other with lower chord members located below the midpoint of the adjacent ones of the upper

chord members via lattice members.

According to this staircase, the lower chord members are arranged below the midpoint of adjacent ones of the upper chord members; for example when there are three upper chord members, two lower chord members are provided. In this case, when seen from the direction of the slope of the staircase, the space truss structural members look trapezoidal, which can provide a simplified appearance. Furthermore, the space truss structural member has a sense of lightness in weight and openness, and creates no sense of oppression even if the staircase is installed indoors. In addition, the adjacent upper chord members are linked and integrated with each other, and as a result, in the space truss structural member, the torsional rigidity of and the flexural rigidity the side-to-side direction are high, and the twisting or rolling of the staircase developed when people are going up and down the staircase is slight. Furthermore, the handrails can be designed as desired because they are not structural members in the main body of the staircase.

In addition, the staircase is a lighter-weight structure than conventional staircases which use heavy members such as channel steel or I-shaped steel, thereby facilitating handling during construction.

When there are two upper chord members, a single lower chord member is used, which makes the space truss structural member look like an inverted triangle when viewed from the direction of the slope of the staircase.

The invention according to Claim 22 is the staircase

according to Claim 21, wherein the space truss structural member further comprises a second lower chord member below the aforementioned lower chord members, and the lower chord members and the second lower chord member are linked to each other by lattice members.

According to this staircase, the second lower chord member further disposed below the lower chord members increases the bending rigidity of the space truss structural member. Furthermore, by disposing the second lower chord member and the lattice members that link the lower chord members and the second lower chord member to each other only at the midpoint between the upper floor and the lower floor, flexure of the truss structural members at the central section of the upper and lower floors where the bending moment increases is restrained.

The invention according to claim 23 is the staircase according to claim 21 or 22, wherein the upper chord member and the lower chord member are each formed by linking a plurality of frame members via node members.

According to this staircase, since the upper chord members and the lower chord members are linked via the plurality of frame members, the length (the number of steps) of the staircase as a whole can be easily controlled by increasing or decreasing the number of frames to be linked.

The invention according to Claim 24 is the staircase according to Claim 23, wherein a reinforcing member is disposed along at least either one of the upper chord member or the lower

chord member of the space truss structural member, and the reinforcing member is fixed to three or more of successive node members.

According to this staircase, in at least either one of the upper chord member or the lower chord member, the plurality of node members are integrated by the reinforcing member and the bending rigidity in the side-to-side direction of the upper chord member is increased, as a result, deformation in the side-to-side direction is restrained. Thereby, rolling of the staircase caused by the load applied in the side-to-side direction when people go up and down the staircase is greatly reduced. Furthermore, since the linking frame members that link the adjacent upper chord members to each other can be lightened in weight or reduced in number, the appearance of the entire staircase is simplified. Furthermore, by forming the reinforcing member to be flat, an L shape, or a groove shape, it becomes easy to manufacture and attach the reinforcing member, and furthermore, when the reinforcing member is formed into an L shape or a groove shape, the frame members that form the upper chord members or the lower chord members are concealed, thereby providing a simple design and improving the vertical rigidity of the space truss structural member. Furthermore, when the reinforcing member has a hollow part at least at a part of its section, the sectional properties thereof are improved, so that the space truss structural member reinforced by this reinforcing member is improved in rigidity in not only the side-to-side direction but also the vertical direction.

The invention according to claim 25 is the staircase according to claim 23, wherein the lattice members and the frame members each have linking end parts on both ends; on outer surfaces of the node members are formed linking grooves into which the linking end parts can be fit; and the linking end parts are fit into the linking grooves.

According to this staircase, the joining between the frame members and the node members, or the joining between the lattice members and the node members can be carried out only by fitting the linking end parts of the aforementioned members which have been processed so as to be fitted into the linking grooves formed on the side faces of the node members, without requiring welding or special tools, thereby proving high in workability.

The invention according to claim 26 is the staircase according to claim 25, wherein adjacent ones of the upper chord members are linked to each other via linking frame members, and the linking frame members each have linking end parts on both ends, the linking end parts being fit into the linking grooves of the node members.

According to this staircase, the joining between the node members and the linking frame members can be carried out only by fitting the linking end parts formed on both ends of the linking frame members into the node members having the linking grooves, without requiring welding or special tools, thereby proving high in workability.

The invention according to Claim 27 is the staircase according to Claim 21 or 22, wherein the upper chord members

have connection pieces that project toward the lower chord members and the lower chord members have connection pieces that project toward the upper chord members, the lattice members have flat end parts on their both ends, and one of the flat end parts is joined to the connection piece of the upper chord member, and the other flat end part is joined to the connection piece of the lower chord member.

According to this staircase, since the linking between the upper chord members and the lower chord members is carried out only by joining the flat end parts of the lattice members to the connection pieces of the upper chord members and the connection pieces of the lower chord members projecting in the connection directions of the lattice members, the work for assembling the space truss structural member becomes easy.

The invention according to Claim 28 is the staircase according to Claim 27, wherein the upper chord members adjacent to each other are linked to each other by the linking frame members, the linking frame members have flat end parts on both ends thereof, each of the upper chord members has a connection piece projecting toward another adjacent upper chord member, and the flat end part of the linking frame member is joined to the connection piece.

According to this staircase, since the linking between the upper chord members is carried out only by joining the flat end parts of the linking frame members to the connection pieces of the upper chord members projecting in the connection directions of the linking frame members, the work for assembling

the space truss structural member becomes easy.

The invention according to claim 29 is the staircase according to claim 26 or 28, wherein the linking frame members include linking diagonal members which are diagonal to each of the upper chord members.

According to this staircase, the linking diagonal members arranged diagonally between the upper chord members can reduce the shearing deformation on the top face of the space truss structural member. In other words, in the space truss structural member, the torsional rigidity and the flexural rigidity the side-to-side direction are improved, which greatly reduces the development of twisting or rolling of the staircase when people are going up and down the staircase.

The invention according to Claim 30 is the staircase according to Claim 21 or 22, wherein the upper chord member is formed of a member having a groove part opened at its lower chord member side, where the groove part houses the node members, and the lower chord member is formed by linking a plurality of frame members by node members, and the lattice member and the frame member have linking end parts on their both ends, and on the outer faces of the node members, linking grooves into which the linking end parts can fit are formed, and the linking end parts are fitted into the linking grooves.

According to this staircase, the upper chord members are formed of members having groove parts and the groove parts house node members, so that a simplified appearance can be obtained. Furthermore, the linking between the lattice members and the

node members is carried out only by fitting the linking end parts of the members processed so as to be fitted into the linking grooves formed on the side faces of the node members, without requiring welding or special tools, thereby providing high workability.

The invention according to claim 31 is the staircase according to claim 21 or 22, wherein adjacent ones of the upper chord members are linked to each other via brackets for supporting the treads.

According to this staircase, the adjacent upper chord members are linked via the brackets, which further reduces the displacement and deformation the side-to-side direction of the space truss structural member. Since the flexure rigidity the side-to-side direction of the staircase as a whole is improved, rolling of the staircase when people are going up and down the staircase can be greatly reduced. Supporting the center part of the treads by the brackets reduces the flexure on the treads. Therefore, the strength of the treads themselves can be small, which extends the range of choices in the structure and material of the treads. By forming tread supporting faces to support the treads on the top faces of the brackets; forming attachment faces for being fixed on the upper chord members on the bottom faces of the brackets; and inclining the attachment faces with the slope of the staircase with respect to the tread supporting faces, the tread supporting faces become horizontal when installed on the top faces of the upper chord members. This facilitates the installing work of the treads, thereby improving

the constructing efficiency.

The invention according to Claim 32 is the staircase according to Claim 21 or 22, wherein the upper chord members adjacent to each other are linked to each other by a plate member.

According to this staircase, since the adjacent upper chord members are integrated by the plate member, shearing deformation of the plane formed by the adjacent upper chord members, that is, the top face of the space truss structural member is reduced. Namely, since the torsional rigidity and the bending rigidity in the side-to-side direction of the space truss structural member are increased by the plate member, the development of twisting and rolling of the space truss structural member when people go up and down the staircase can be further restrained. In this case, the plate member may be extrusion molded integrally with the upper chord members. Thereby, since the adjacent upper chord members are integrated in advance, the number of parts is reduced and construction of the space truss structural member becomes easy.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the staircase according to the first embodiment of the present invention.

FIG. 2 is a side view of the staircase shown in FIG 1.

FIG. 3 is an enlarged side view of the staircase shown in FIG. 1.

FIG. 4 is a front view of the staircase shown in FIG. 1.

FIG. 5(a) is a plan view of the treads, and FIG. 5(b) is a front view of the same.

FIG. 6(a) is a perspective view of the frame members composing the upper chord members and the lower chord members, FIG. 6(b) is a perspective view of the frame members composing the lattice members, and FIG. 6(c) is a side view of the frame member shown in FIG. 6(b).

FIG. 7(a) is a perspective view of the linking members, and FIG. 7(b) is an end view of the same.

FIG. 8 is a perspective view of an example of the node members provided to the upper chord members.

FIG. 9 is a perspective view of an example of the node members provided to the lower chord members.

FIG. 10 is a plan view of the node members.

FIG. 11 (a) is an enlarged side view of the handrail, and FIG. 11(b) is a further enlarged view of FIG. 11(a).

FIG. 12(a) and FIG. 12(b) are front views of the balusters, and FIG. 12(c) is an enlarged front view of FIG. 12(b).

FIG. 13(a) is a cross sectional view of the joint part between the handrail and the baluster, and FIG. 13(b) is a top view of the same.

FIG. 14 is a perspective view of the staircase according to the second embodiment of the present invention.

FIG. 15 is a side view of the staircase shown in FIG. 14.

FIG. 16 is an enlarged side view of the staircase shown in FIG. 14.

FIG. 17 is a front view of the staircase shown in FIG.14.

FIG. 18 is a plan view of the treads, and FIG. 18(b) is a cross sectional view of the same.

FIG. 19 is a perspective view of the horizontal lattice members.

FIG. 20 is a perspective view of the staircase according to the third embodiment of the present invention.

FIG. 21 (a) is a simplified plan view of the frame members and the node members in the case of forming a curved truss structural member, FIG. 21(b) is a plan view of the frame member shown in FIG. 21(a).

FIG. 22(a) and FIG. 22(b) are perspective views of other examples of the staircase according to the third embodiment.

FIG. 23 is a side view of the staircase according to the fourth embodiment of the present invention.

FIG. 24 is an enlarged side view of the staircase where is partly broken shown in FIG. 23.

FIG. 25 (a) is a cross sectional view taken along the line X-X of FIG. 24, FIG. 25 (b) is a cross sectional view taken along the line Y1-Y1 of FIG. 24, and FIG. 25(c) is an end view taken along the line YC-YC of FIG. 24.

FIG. 26 (a) is a cross sectional view taken along the line Y2-Y2 of FIG. 24 and FIG. 26 (b) is a cross sectional view taken along the line Y3-Y3 of FIG. 24.

FIG. 27 is a plan view of the treads, and FIG. 27(b) is a front view of the same.

FIG. 28 is a plan view of another type of tread, and FIG.

28(b) is a front view of the same.

FIG. 29 is a cross sectional view of another example of the upper chord members of the staircase according to the fourth embodiment, and FIG. 29(b) is a cross sectional view of another example of the lower chord members.

FIG. 30 is a cross sectional view of the upper chord members of the staircase according to the fifth embodiment of the present invention.

FIG. 31 is an enlarged side view of the staircase according to the fifth embodiment of the present invention.

FIG. 32 is a side view of the staircase according to the sixth embodiment of the present invention.

FIG. 33 is an enlarged side view of the staircase where is partly broken shown in FIG. 32.

FIG. 34 (a) is a cross sectional view taken along the line Y5-Y5 of FIG. 32, and FIG.34(b) is a cross sectional view of the linking members.

FIG. 35 (a) is an exploded perspective view of the truss structural members, and FIG. 35(b) is a perspective view showing the state where an upper reinforcing member and a lower reinforcing member are installed in one of the truss structural members.

FIG. 36 is an exploded perspective view of the staircase according to the sixth embodiment of the present invention.

FIG. 37 (a) is a view showing another cross sectional shape of the upper reinforcing members and the lower reinforcing members, and FIG. 37(b) is a cross sectional view showing the

state where the upper reinforcing member is exclusively installed.

FIG. 38 is a perspective view of the staircase according to the seventh embodiment of the present invention.

FIG. 39 is a perspective view showing the staircase according to the eighth embodiment of the present invention.

FIG. 40 is a perspective view of another example of the staircase according to the eighth embodiment of the present invention.

FIG. 41 is a perspective view of a staircase according to the ninth embodiment of the invention.

FIG. 42 is a side view of the staircase shown in FIG. 41.

FIG. 43(a) is an enlarged view of FIG. 42, which is partly broken, and FIG. 43(b) is a view seen from the direction of the arrows A-A of FIG. 43(a).

FIG. 44(a) is a perspective view describing a method for joining the upper node members (upper hubs) and the upper frame members, and FIG. 44(b) is a perspective view describing a method for joining the lower node members (lower hubs) and the lower frame members.

FIG. 45 is a cross sectional view showing the state of joining of the upper node member (upper hub), the upper frame members, and the lattice members.

FIG. 46(a) is a perspective view showing the upper frame member, and FIG. 46(b) is a side view of FIG. 46(a).

FIG. 47(a) is a view seen from the direction of the arrows

B-B of FIG. 43, and FIG. 47(b) is a view seen from the direction of the arrows C-C of FIG. 43.

FIG. 48(a) is an enlarged view of the lower part of FIG. 42, FIG. 48(b) is a cross sectional view along D-D of FIG. 48(a), and FIG. 48(c) is a view seen from the direction of the arrows E-E of FIG. 48(a).

FIG. 49(a) and FIG. 49(b) are exploded perspective views describing construction procedures of the staircase according to the ninth embodiment.

FIG. 50 is an exploded perspective view describing construction procedures of the staircase according to the ninth embodiment.

FIG. 51 is a perspective view showing another example of the staircase according to the ninth embodiment.

FIG. 52(a) is an enlarged side view showing still another example of the staircase according to the ninth embodiment, and FIG. 52(b) is a cross sectional view along F-F of FIG. 52(a).

FIG. 53(a) and FIG. 53(b) are perspective views showing modified examples of the tread receiving members.

FIG. 54(a) and FIG. 54(b) are perspective views showing still another modified example of the tread receiving members.

FIG. 55(a) and FIG. 55(b) are perspective views showing a modified example of the treads.

FIG. 56 is a side view showing an example for coping with a case where the slope of the staircase is changed.

FIG. 57 is a perspective view of the staircase as a whole according to the tenth embodiment of the present invention.

FIG. 58 is a front view of the staircase shown in FIG. 57.

FIG. 59 is a side view of the staircase shown in FIG. 57.

FIG. 60 is an enlarged side view of the staircase shown in FIG. 59.

FIG. 61 is an exploded perspective view of the staircase of the tenth embodiment.

FIG. 62 (a) is a view seen from the direction of the arrows X1-X1 of FIG. 59, and FIG. 62(b) is a view seen from the direction of the arrows X2-X2 of FIG. 62(a).

FIG. 63 (a) is a perspective view of the frame members and the linking frame members, FIG. 63(b) is a plan view of the same, FIG. 63(c) is a perspective view of the lattice members, and FIG. 63(d) is a plan view of the same.

FIG. 64 is a perspective view to explain the node members (hubs).

FIG. 65 is a plan view of the node members shown in FIG. 64.

FIG. 66 (a) is a cross sectional view taken along the line X3-X3 of FIG. 59, and FIG. 66(b) is a view seen from the direction of the arrows X4-X4 of FIG. 59.

FIG. 67(a) is a perspective view of the brackets, and FIG. 67(b) is a side view of the same.

FIG. 68(a), FIG. 68(b), and FIG. 68(c) are side views of the support shoes.

FIG. 69 is an exploded perspective view of the staircase

according to the eleventh embodiment of the present invention.

FIG. 70(a) is a plan view showing the arrangement of the upper chord members and the linking frame members in a space truss structural member composing the staircase according to the eleventh embodiment of the present invention, FIG. 70(b) is a plan view showing the arrangement of the lower chord member and the lattice members of the same, and FIG. 70(c) is a side view of the space truss structural member.

FIG. 71 is a side view of the staircase according to the eleventh embodiment of the present invention.

FIG. 72 is an enlarged side view of the staircase shown in FIG. 71.

FIG. 73 is an exploded perspective view of the staircase according to the twelfth embodiment of the invention.

FIG. 74 is a view of the space truss structural member shown in FIG. 73 seen from the direction of the staircase inclination and the bracket and the tread seen from the staircase front side.

FIG. 75 is a view of the space truss structural member of the staircase according to the thirteenth embodiment of the invention seen from the direction of the staircase inclination and the bracket and the tread seen from the staircase front side.

FIG. 76 is a side view relating to the staircase according to the thirteenth embodiment of the invention.

FIG. 77 is an exploded perspective view of the staircase according to the fourteenth embodiment of the invention.

FIG. 78(a) and FIG. 78(b) are exploded perspective views of the staircase according to the fifteenth embodiment of the invention.

FIG. 79(a) is a view of the space truss structural member of FIG. 78(b) seen from the direction of the staircase inclination and the bracket and the tread seen from the staircase front side, FIG. 79(b) is a view showing a modified example of the staircase according to the fifteenth embodiment of FIG. 78(b).

FIG. 80(a), FIG. 80(b), and FIG. 80(c) are views showing other modified examples of the staircase according to the fifteenth embodiment.

FIG. 81(a) and FIG. 81(b) are exploded perspective views of the staircase according to the sixteenth embodiment of the invention.

FIG. 82 is a side view of the staircase shown in FIG. 81(a) and FIG. 81(b).

FIG. 83(a) is a view seen from the direction of the arrows X7-X7 of FIG. 82, FIG. 83(b) and FIG. 83(c) are views showing modified examples of the staircase according to the sixteenth embodiment.

FIG. 84 is a perspective view partially omitting the staircase according to the seventeenth embodiment of the invention.

FIG. 85(a) is a view of the space truss structural member of FIG. 84 seen from the direction of the staircase inclination, and FIG. 85(b) is a side view of FIG. 84.

FIG. 86 is a perspective view showing the linking frame member and the lattice member.

FIG. 87 is a perspective view partially omitting the staircase according to the eighteenth embodiment of the invention.

FIG. 88 is a view of the space truss structural member shown in FIG. 87 seen from the direction of the staircase inclination.

BEST MODE FOR CARRYING OUT THE INVENTION

The preferable embodiments of the present invention will be described as follows with the drawings.

<First Embodiment>

As shown in FIG. 1 through FIG. 4, the staircase according to a first embodiment of the present invention is composed of truss structural members 10 and 10, which are a pair of right and left stringers; a plurality of linking members 11 for linking the stringers; treads 12 which are fixedly supported on the linking members 11; handrails 15 which are located above the side end parts of the treads 12; and balusters 13 and 14 for supporting the handrails 15. In addition, in the present embodiment, between the bottom ends of the truss structural members 10 and the floor face 7 lower floor are disposed support shoes 6a and 6b, and between the top ends of the truss structural members 10 and the beam member 8a upper floor are disposed support shoes 6c.

The truss structural members 10, as shown in FIG. 2 and FIG. 3, are each composed of an upper chord member 1 and a lower chord member 2 which are inclined with the slope of the staircase; and a plurality of lattice members 4 for linking them. In the present embodiment, the upper chord member 1 and the lower chord member 2 are each composed of a plurality of frame members 3 linked to each other via hubs 5 which are node members, the lattice members 4 being composed of the same members as the frame members 3. Thus, the truss structural members 10 are each composed of the plurality of frame members 3 and the hub 5 for linking them, the end parts of the frame members 3 being joined with the hubs 5 each arranged at each node.

The frame members 3, as shown in FIG. 6(a), are each composed of a tubular member having flat-shaped linking end parts 3a formed at both ends thereof, the linking end parts 3a having notches at their tips. The frame members 3 are extrusions of aluminum alloy, and the linking end parts 3a are formed by press working or the like. Since they are long flattened in the axial direction of the hubs 5 (See FIG. 8 and FIG. 9), the linking end parts 3a have a joint structure strong against the external force in the axial direction of the hubs 5.

The lattice members 4 are composed of the same kind of members as the frame members 3, and as shown in FIG. 6 (b) and 6(c), the tips of the linking end parts 4a are cut at an angle α (hereinafter referred to as the coin angle α) with respect to the axial direction of the frame members 3.

The hubs 5, as shown in FIG. 8 and FIG. 9, are column-shaped

extrusions or casts of aluminum alloy. The hubs 5 are each provided with a plurality of linking grooves 5a carved on their outer surface along their axial direction. The linking grooves 5a have the same cross sectional shape as the tip parts of the linking end parts 3a of the frame members 3 and the tip parts of the linking end parts 4a of the lattice members 4, and their inner walls are provided with notches which are formed to be engaged with the notches of the linking end parts 4a (3a). The hubs 5 arranged along the upper chord members 1 and the hubs 5 arranged along the lower chord members 2 have almost the same structure; however, they are shaped so as to be coincident with the number and angle of the members to be joined with the hubs 5. For example, the hubs 5 on the upper chord members 1 side have a height which allows a lattice member 4, a frame member 3, and balusters 13 and 14 to be press fit therein sequentially (the length in the direction of the linking grooves 5a) (See FIG. 8), and the hubs 5 on the lower chord members 2 side have a height which allows a frame member 3 and a lattice member 4 to be press fit therein sequentially (See FIG. 9).

The linking end part 3a of a frame member 3 is press fit into the linking groove 5a of a hub 5 from the upper-face side or the lower-face side of the hub 5 so as to join the frame member 3 with the hub 5. At this time, as shown in FIG. 10, the notches formed on each of the linking grooves 5a and the linking end parts 14a are engaged with each other, so it never occurs that the frame member 3 is pulled out in the axial direction.

The joint between the lattice members 4 and the hubs 5 is performed in the same manner as above except that the lattice members 4 are joined with the linking grooves 5a with an inclination of the coin angle α because the linking end parts 4a of the lattice members 4 have an inclination of the coin angle α at their tips as shown in FIG. 6(c).

The linking members 11, as shown in FIG. 7(a) and 7(b), each have flat-shaped linking end parts 11a and a tread supporting part 11b on which one of the treads 12 is fixedly supported and which is horizontally laid between the right and left upper chord members 1 and 1 (See FIG. 4). The distance between vertically adjacent ones of the linking members 11, that is, the difference in height between two of the linking members 11 adjacent in the height direction equals the height of the riser. The linking end parts 11a have the same shape as the linking end parts 3a of the frame members 3, and can be press fit into the linking grooves 5a of the hubs 5. The linking members 11 are extrusions of aluminum alloy, and the linking end parts 11a are formed by press working or the like. The portions to be pressed are cut beforehand in order to prevent the tread supporting parts 11b from hindering the press working. The top faces of the tread supporting parts 11b are disposed horizontally, whereas the linking grooves 5a of the hubs 5 (the axis of the hubs 5) into which the linking end parts 11a are press fitted are formed in the direction orthogonal to the direction of the slope of the staircase (See FIG. 7(b)), so the press working of the linking end parts 5a is performed in

the direction rotated by an angle θ from the direction perpendicular to the top faces of the tread supporting parts 11b.

It is possible to link the lower chord members 2 and 2 on the right and left sides with each other, although this is not illustrated. In this case, the linking members preferably have the same structure as the frame members 3, and when the lower chord members 2 and 2 are linked to each other via the linking members, the linking end parts can be press fit into the linking grooves 5a of the hubs 5.

The treads 12, as shown in FIG. 5(a) and FIG. 5(b), are plate members made of wood or metal, and are fixed on the tread supporting parts 11b with screws, nails, or bolts.

The balusters 13, as shown in FIG. 12(a), are tubular members having flat-shaped linking end parts 13a at both ends, the linking end parts 13a having notches at their tips. The balusters 13 are extrusions of aluminum alloy, and the linking end parts 13a are formed by press working or the like. The tips of the linking end parts 13a are shaped to form the coin angle α with the axial direction (See FIG. 11(a).

The balusters 14 are tubular members of which low parts have been subjected to a bending process in such a manner as to be curved in the direction orthogonal to the handrails (to the right side in FIG. 12(b)), that is, outwardly curved from the faces formed by the handrails 15 and the balusters 13. At the both ends of the balusters 14 are formed flat-shaped linking end parts 14a having notches at their tips. The balusters 14

are extrusions of aluminum alloy, and the linking end parts 14a are formed by press working or the like. Since the axial direction of the balusters 14 is different from the direction of the linking grooves 15b of the handrails 15, the linking end parts 14a on the upper end side of the balusters 14 are bent so as to form an angle β (hereinafter, bent angle β) with the axial direction of the balusters 14 (See FIG. 12(c)), thereby matching the direction of the linking end parts 14a with the direction of the linking grooves 15b.

The handrails 15, as shown in FIG. 13(a), are each composed of a rail member 15a having a linking groove 15b formed on its bottom face, and a handrail cover 15c for covering the rail member 15a. The linking grooves 15b have the same cross sectional shape as the linking end parts 13a and 14a on the upper end side of the balusters 13 and 14, and the inner walls of the linking grooves 15b have notches which are supposed to be engaged with the notches formed on the linking end parts 13a and 14a. In FIG. 13(a), the reference symbol 15d represents a joint piece used to join a plurality of rail members 15a together. In the case of a straight staircase as shown in FIG. 1, it is possible to use a single rail member for each hand rail; however, in the case of a curved staircase or when it is difficult to insert the linking end parts 13a and 14a of the balusters 13 and 14 from the end parts of the linking grooves 15b, a plurality of short rail members 15a can be joined together via the joint pieces 15d (See FIG. 13(b)).

FIG. 13(b) is a view seen from the direction of the arrow

"b" of FIG. 13(a) and shows the case where the staircase is curved as shown in FIG. 20, FIG. 22(a), and FIG. 22(b) described later.

The following is a description regarding the construction process of the staircase according to the first embodiment. In the following description, the aforementioned members are assembled in sequence at a building site of the staircase; however, instead of this, it is also possible to assemble some units of members integrated in consideration of efficiency in carrying and constructing.

First, the truss structural members 10 and 10 are laid between the floor board 7 lower floor and the beam member 8a upper floor with a prescribed distance between the truss structural members 10 and 10. Between the bottom ends of the truss structural members 10 and the floor face 7 lower floor are disposed support shoes 6a and 6b, and between the top ends of the truss structural members 10 and the beam member 8a upper floor are disposed support shoes 6c. The installing work of the truss structural members 10 and 10 is easy because these members are much lighter in weight than the conventional stringers made of channel steel or I-shaped steel.

Next, the truss structural members 10 and 10 are linked to each other via the linking members 11, and the treads 12 are fixedly supported on the tread supporting members 11b of the linking members 11. The truss structural members 10 and 10 can be linked to each other via the linking members 11 just by press fitting one side of the linking end parts 11a of the

linking members 11 into the hubs 5 composing the upper chord member 1 of the right-side truss structural member 10, and the other side of the linking end parts 11a of the linking members 11 into the hubs 5 composing the upper chord member 1 of the left-side truss structural member 10, and then by applying later-described washers for preventing pulling out. The linking members 11, of the right and left truss structural members 10, are set horizontal by being joined with the hubs 5 and 5 positioned at the same height. The treads 12, as shown in FIG. 5(a) and 5(b), are laid on the top faces of the tread supporting parts 11b of the linking members 11, and are fixedly supported on the linking members 11 with bolts or wooden screws which are inserted from the rear side of the tread supporting parts 11b. Fixing the treads 12 on the linking members 11 in advance facilitates the operation at a building site.

In addition, the handrail parts are assembled in advance. To be more specific, as shown in FIG. 12 and FIG. 13(a), the linking end parts 13a and 14a on the upper side of the balusters 13 and 14 are press fit into the linking grooves 15b formed on the rail members 15a of the handrails 15 so as to join the handrails 15 and the balusters 13 and 14 together. When the right and left rail members 15a are each composed of a single long-sized member, the linking end parts 13a and 14a on the upper side of the balusters 13 and 14 are inserted from an end part of the rail members 15a and assembled.

Later, the linking end parts 13a and 14a on the bottom side of the balusters 13 and 14 are press fit into the linking

grooves 5a of the hubs 5 so as to join the balusters 13 and 14 and the hubs 5 together. Since the linking end parts 13 have been cut at the coin angle α, the balusters 13 are joined at an inclination of „ degree from the axis of the hubs 5.

As shown in FIG. 11(b), on the top and bottom faces of the hubs 5 are fixed washers 5d with bolts and nuts so as to prevent the frame members 3, the lattice members 4, and the like from being pulled out in the direction of the linking grooves 5a, and then the bolts and nuts are covered with ornamental caps 5c.

As described hereinbefore, the staircase of the present embodiment enables the members to be joined with each other just by press fitting, which facilitates the assembly and reduces the number of components used for linking, thereby being economical. Furthermore, the truss structural members 10, which look lighter in weight and have a sense of more openness than the conventional heavy members such as channel steel or I-shaped steel, creates no sense of oppression even if the staircase is installed indoors. In addition, no welding or special tools are required for the joint between the members and the hubs 5, which provides high in workability.

Since the linking members 11 are laid between the upper chord members 1 and 1 of the truss structural members 10 and 10 and the treads 12 are fixedly supported on the top faces of the linking members 11, the truss structural members 10 and 10 never protrude above the treads 12. Therefore, for example, when the staircase of the present embodiment is constructed

along a wall face, the wall face and the truss structural member 10 do not overlap each other above the treads 12, which can maintain the appearance of the staircase.

In the right and left truss structural members 10 and 10, the upper chord members 1 and 1 are linked to each other via the linking members 11, and as a result, the torsional rigidity of the staircase as a whole and the flexural rigidity the side-to-side direction are improved, which greatly reduces the development of twisting or rolling of the staircase when people are going up and down the staircase.

Integrating the members into some units can further improve constructing efficiency. For example, when all the components (the truss structural members 10 and 10, the linking members 11, the treads 12, the balusters 13 and 14 and the handrails 15) are integrated into one unit, the constructing of the staircase can be completed only by installing this unit between the floor board 7 lower floor and the beam member 8a upper floor, which enables the staircase to be constructed in a short time. It is also possible to assemble the truss structural members 10, the handrails 15, and the balusters 13 and 14 beforehand.

<Second Embodiment>

The staircase according to a second embodiment of the present invention, as shown in FIG. 14 through FIG. 17, is composed of truss structural members 20 and 20, which are a pair of right and left stringers; treads 22 which are fixedly

supported on the truss structural members 20; handrails 15 which are located above the side end parts of the treads 22; and balusters 13 and 14 for supporting the handrails 15. In addition, in the present embodiment, as shown in FIG. 16, between the bottom ends of the truss structural members 20 and the floor face lower floor are disposed support shoes 23a, and between the top ends of the truss structural members 20 and the floor board 8 upper floor are disposed support shoes 23b.

The truss structural members 20, as shown in FIG. 15 and FIG. 16, are each composed of an upper chord member 1 and a lower chord member 2 which are inclined with the slope of the staircase, and a plurality of lattice members 4 for linking these chord members. In the present embodiment, the upper chord member 1 and the lower chord member 2 are each composed of a plurality of frame members 3 linked to each other via hubs 5, the lattice members 4 being composed of the same members as the frame members 3. Thus, the truss structural members 20 are each composed of the plurality of frame members 3 and the hubs 5 for linking them, the end parts of the frame members 3 being joined with the hubs 5 each arranged at each node. Some of the lattice members 4 are laid horizontally at the height of the risers (hereinafter referred to as the horizontal lattice members 21).

The horizontal lattice members 21, as shown in FIG. 19, are each composed of flat-shaped linking end parts 21a and a tread supporting part 21b on which to fixedly support one of the treads 22, and laid horizontally at the height of the risers

(See FIG. 15). The linking end parts 21a have the same cross sectional shape as the linking end parts 3a of the frame member 3 described in the first embodiment, but the tip parts of the linking end parts 21a have the coin angle α because the axis of the horizontal lattice members 21 is not orthogonal to the axis of the hubs 5. The horizontal lattice members 21 are extrusions of aluminum alloy, and the linking end parts 21a are formed by press working or the like. The portions to be pressed are cut beforehand in order to prevent the tread supporting parts 21b from hindering the press working.

The treads 22, as shown in FIG. 18(a) and FIG. 18(b), are plate members made of wood or metal. In order to avoid contact with the upper chord members 1 and the lattice members 4, U-shaped cuttings are formed. The treads 22 are fixedly supported on the horizontal lattice members 21 composing the truss structural members 20 with screws, nails or bolts, whereby the right and left side truss structural members 20 and 20 are linked to each other via the treads 22.

The structures of the frame members 3, the lattice members 4, the hubs 5, the balusters 13 and 14, and the handrails 15 and the method for joining them will not be described in detail here because they are the same as those described in the first embodiment.

The staircase according to the second embodiment also enables the members to be joined together just by press fitting, which facilitates the assembly and reduces the number of components used for linking, thereby being economical.

Furthermore, before the attachment of the treads 22, a stack of truss structural members 20 can be carried together, thereby providing high carrying efficiency.

When the staircase is viewed from the side, the treads are positioned between the upper chord members and the lower chord members, providing a simplified appearance. Furthermore, the truss structural members 20, which look lighter in weight and have a sense of more openness than the conventional heavy members such as channel steel or I-shaped steel, creates no sense of oppression even if the staircase is installed indoors.

<Third Embodiment>

The staircase according to a third embodiment of the present invention, as shown in FIG. 20, has curved truss structural members 30 and 30. The other components are almost identical to the staircase according to the second embodiment.

The truss structural members 30 are each composed of an upper chord member 31 and a lower chord member 32 which are inclined with the slope of the staircase, and a plurality of lattice members 34 for linking the chord members together. In the present embodiment, the upper chord member 31 and the lower chord member 32 are each composed of a plurality of frame members 33 linked to each other via hubs 5, the lattice members 34 being composed of the same members as the frame members 33. Thus, the truss structural members 30 are each composed of the plurality of frame members 33 and the hubs 5 for linking them, the end parts of the frame members 33 being joined with the

hubs 5 each arranged at each node. Some of the lattice members 34 are laid horizontally at the height of the risers (hereinafter referred to as the horizontal lattice members 35).

The frame members 33 have almost the same structure as the frame members 3 described in the first and second embodiments; however, as shown in FIG. 21(b), the tips of the linking end parts 33a of the frame members 33 are bent at a necessary angle with respect to the axis of the frame members 33 (hereinafter, bent angle β). The bent angle β is calculated by the function of the curve shape, the truss shape, and the length of the frame members 33. Such a shape can be formed easily by press working or the like.

As shown in FIG. 21(a), such frame members 33 can be sequentially linked together via the hubs 5 to structure the curved truss structural members 30.

A curved staircase can be easily constructed by composing the truss structural members 30 from a plurality of frame members 33 and bending the linking end parts 33a of the frame members 33 at a prescribed angle. To be more specific, in the conventional constructing of spiral staircases or staircases having a curve when viewed in a plane, it has been necessary to apply a bending process to the stringers made of I- or H-shaped steel, requiring a great deal of trouble and cost. On the other hand, in the staircase according to the present embodiment, the frame members 33 can be formed only by applying a simple process to the frame members 3 shown in FIG. 6(a), and when it comes to hubs, the same hubs 5 as those for straight staircases

can be used, which is very economical.

Furthermore, the same structure and procedure can be used to construct staircases in which the distance (the width of the treads 22) between the truss structural members changes gradually like the truss structural members 40 and 50 shown in FIG. 22(a) and FIG. 22(b), or unillustrated S-shaped staircases. As shown in FIG. 13(b), when each of the handrails 15 has a joint, the joint piece 15d is inserted inside the rail member 15a.

<Fourth Embodiment>

In the aforementioned embodiments, the upper chord members 1 and the lower chord members 2 are each formed by linking a plurality of frame members 3; however, besides this, it is also possible to form the upper chord members and the lower chord members by using members long enough to cover the whole length of the truss structural members.

In the staircase according to a fourth embodiment of the present invention, as shown in FIG. 23, the upper chord members 61 and the lower chord members 62 composing the truss structural members 60 which are stringers are formed to be long enough to cover the whole length of the truss structural members 60. In the same manner as each of the aforementioned embodiments, the truss structural members 60 are disposed right and left and linked to each other via the plurality of linking members 65 on which the right and left upper chord members 61 and 61 are laid horizontally at every riser height, and on the top

faces of the linking members 65 are fixedly supported the treads 66. In addition, in the present embodiment, between the bottom ends of the truss structural members 60 and the floor face 7 lower floor are disposed support shoes 67a and 67b, and between the top end of the truss structural members 60 and the beam member 8a upper floor are disposed support shoes 67c.

The truss structural members 60 are each composed of an upper chord member 61, a lower chord member 62, hubs 64 (See FIG. 24) disposed in each of the upper chord member 61 and the lower chord member 62, and a plurality of lattice members 63 for linking the upper and lower chord members 61 and 62.

The upper chord members 61 are made of aluminum alloy, and as shown in FIG. 25(b) and FIG. 25(c), are each shaped to have a groove part 61f which extends in the direction of the slope of the staircase and which is opened on the lattice member 63 side. To be more specific, the upper chord members 61 are extrusions each having a groove-shaped cross section with an opened bottom face (a member having the groove part 61f), and on the top face inside the groove parts 61f are formed two ridge portions 61a extending in the longitudinal direction, and on the bottom of the side face inside the groove parts 61f are formed ridge portions 61b extending in the longitudinal direction. On the bottom faces of the upper chord members 61, as shown in FIG. 24, are provided lid members 61c for covering the openings near the hubs 64, and lid members 61 for covering the openings on the other locations.

The lid members 61c, as shown in FIG. 25(b), are fixed

by burying their side end parts into the grooves which have a U-shaped cross section and are formed by the inner face of the upper chord member 61 and the ridge portions 61b. The lid members 61d, which have nearly the same shape as the lid members 61c as shown in FIG. 25(c), are provided with locking pieces 61e formed on their top faces in such a manner as to project into the upper chord members 61, and are fixed by locking the locking pieces 61e with the ridge portions 61b of the upper chord members 61. Since the openings of the upper chord members 61 are closed by the lid members 61c and 61d, the appearance is improved. The lid members 61c also serve to prevent the pulling out of the lattice members 63 joined with the hubs 64.

The lower chord members 62 are made of aluminum alloy, and as shown in FIG. 26(a) and FIG. 26(b), are each shaped to have a groove part 62f which extends in the direction of the slope of the staircase and is opened on the lattice member 63 side. To be more specific, the lower chord members 62 are extrusions having a groove-shaped cross section with an opened top face (a member having the groove part 62f) and are open on the lattice member 63 side, and on the bottom face inside are formed two ridge portions 62a extending in the longitudinal direction, and on the top of the side face inside are formed ridge portions 62b extending in the longitudinal direction. On the top faces of the lower chord members 62, as shown in FIG. 24, are provided lid members 62c for covering the openings near the hubs 64, and lid members 62d for covering the openings on the other locations.

The lid members 62c and the lid members 62d, as shown in FIG. 26(a) and FIG. 26(b), have the same structure as the lid members 61c and the lid members 61d shown in FIG. 25(b) and FIG. 25(c) to be installed in the upper chord members 61. The lower cord members 62 have an opened top face which can be closed by the lid members 62c and 62d to prevent dust accumulation inside.

The lattice members 63, like the lattice members 4 shown in FIG. 6(b) are tubular members having flat-shaped linking end parts 63a at both ends (See FIG. 24), the linking end parts 63a having notches at their tips (See FIG. 25(a)). In the lattice members 63, the tips of the linking end parts 63a have been cut at the angle α (hereinafter referred to as the coin angle α) in the same manner as in the lattice members 4 shown in FIG. 6(c). The lattice members 63 are extrusions of aluminum alloy, and the linking end parts 63a are formed by press working or the like. Since they are long flattened in the axial direction of the hubs 64, the linking end parts 63a have a joint structure strong against the external force in the axial direction of the hubs 64.

The hubs 64, as shown in FIG. 25(a) and FIG. 25(b), are column-shaped and each have a bolt insertion hole 64c in the center. On the outer surfaces of the hubs 64 are carved linking grooves 64a along the axial direction of the hubs 64. The linking grooves 64a have the same cross sectional shape as the tip parts of the linking end parts 63a of the lattice members 63, and their inner walls are provided with notches which are formed

to be engaged with the notches of the linking end parts 63a. The hubs 64 are shaped to have an oval cross section and are buried between the ridge portions 61a and 61a on the top faces and between the ridge portions 61b and 61b on the side faces of the upper chord members 61. The hubs 64 are installed in the lower chord members 62 in the same manner. Covering the head parts of bolts B penetrating the hubs 64 and nuts N with semispherical caps 64b improves the appearance.

The hubs 64 are installed inside the upper chord members 61 and the lower chord members 62 at intervals of the riser height, and the linking end parts 63a of the lattice members 63 are press fit into the linking grooves 64a of the hubs 64 so as to join the lattice members 63 and the hubs 64, thereby constructing the truss structural members 60. At this time, as shown in FIG. 25(a), the notches formed on each of the linking grooves 64a and the linking end parts 63a are engaged with each other, which prevents the lattice members 63 from being pulled out in the axial direction.

The lattice members 63 are joined with the linking grooves 64a at an inclination of the coin angle α because the linking end parts 63a of the lattice members 63 have an inclination of the coin angle α at their tips.

The linking members 65, as shown in FIG. 24, are hollow members having a polygonal cross section and are each composed of an inclined face (hereinafter referred to as the attachment face 65b) which is inclined with the slope of the staircase to come into contact with the top face of the upper chord member

61; and a horizontal face on which one of the treads 66 is placed (hereinafter referred to as the tread supporting face 65a). And the linking members 65 are fixed on the upper chord members 61 in cooperation with the hubs 64 via the bolts B inserted into the bolt insertion holes 64c of the hubs 64 from inside the linking members 65. The vertically adjacent linking members 65 (the tread mounting faces 65a) are arranged at intervals of the riser height.

The treads 66 are plate members made of wood or metal, and are fixed on the tread supporting faces 65a of the linking members 65 with screws, nails, or bolts as shown in FIG. 27.

The following is a description of the constructing process of the staircase according to the fourth embodiment. In the following description, the aforementioned members are assembled in sequence at a building site of the staircase; however, instead of this, it is also possible to assemble some units of members integrated in consideration of efficiency in carrying and constructing.

First, the truss structural members 60 are laid between the floor board 7 lower floor and the beam member 8a upper floor with a prescribed distance between the truss structural members 60. As shown in FIG. 23, between the bottom ends of the truss structural members 60 and the floor face 7 lower floor are disposed support shoes 67a and 67b, and between the top ends of the truss structural members 60 and the beam member 8a upper floor are disposed support shoes 67c. The installing work of the truss structural members 60 and 60 is easy because these

members are much lighter in weight than the conventional stringers made of channel steel or I-shaped steel.

Next, the truss structural members 60 and 60 are linked to each other by fixing the linking members 65 on the top faces of the upper chord members 61. The linking members 65, as shown in FIG. 24, are installed to the hubs 64 so as to be fixed on the top faces of the upper chord members 61 with bolts B inserted into the bolt insertion holes 64c of the hubs 64 from inside the linking members 65.

Then, the treads 66 are fixedly supported on the tread supporting faces 65a of the linking members 65. Fixing the treads 66 on the linking members 65 in advance facilitates the operation at a building site.

Furthermore, the balusters 13 and 14 are installed on the upper chord members 61 and the treads 66, and then the handrails 15 are attached to the top ends of the balusters 13 and 14 so as to complete the constructing of the staircase. Fixing the balusters 13 and 14 to the handrails 15 in advance can reduce the constructing time at a building site.

Similar to the staircases of the above embodiments, the staircase according to the fourth embodiment enables the members to be easily integrated into units. And the truss structural members 60, which look lighter in weight and have a sense of more openness than the conventional heavy members such as channel steel or I-shaped steel, creates no sense of oppression even if the staircase is installed indoors. Furthermore, the hubs 64 are installed inside the upper chord members 61 and the lower

chord members 62, providing a simplified appearance.

In the fourth embodiment, the treads 66 are fixedly supported on the top faces of the linking members 65; however, as shown in FIG. 28, it is also possible to place block-shaped supporting members 68 and 68 having the same cross sectional shape as the linking members 65 on the top faces of the right and left upper chord members 61 and 61, and to place the treads 66 on the top faces of the supporting members 68 and 68. In this case, the right and left pair truss structural members 60 and 60 are linked to each other via the treads 66. This allows the truss structural members 60 to be carried in a stacked condition, which provides high carrying efficiency.

The upper chord members 61 are not restricted to the one shown in FIG. 25(b), and for example like the upper chord members 61′ shown in FIG. 29(a), can be each composed of a groove part 61f having an opened bottom face and a hollow part 61g. The provision of the hollow parts 61g beside the groove parts 61f can improve the rigidity of the upper chord members 61′, thereby forming a cross sectional structure strong against the vertical load and axial compression applied to the upper chord members 61. In this case, the hubs 64 are installed inside the groove parts 61f.

In the same manner, the lower chord members 62 are not restricted to the one shown in FIG. 26(a), and for example like the lower chord members 62′ shown in FIG. 29(b), can be each composed of a groove part 62f having an opened top face and a hollow part 62g. The provision of the hollow parts 62g beside

the groove parts 62f can improve the rigidity of the lower chord members 62'. In this case, the hubs 64 are installed inside the groove parts 62f.

Forming the truss structural members 60 by the upper chord members 61' and the lower chord members 62' can greatly reduce the development of vertical flexure, twisting or rolling of the staircase when people are going up and down the staircase.

In the present embodiment, both the upper chord members 61 and the lower chord members 62 are made long enough to cover the whole length of the truss structural members 60; however, it is also possible to make one of them long enough to cover the whole length of the truss structural members 60 and to compose the other by short-sized frame members linked via node members (hubs) as shown in the second embodiment.

<Fifth Embodiment>

In the fourth embodiment, the upper chord members 61 and the lower chord members 62 are each composed of members having a groove part, and the hubs 64 are installed inside the groove parts; however, like the staircase according to a fifth embodiment shown in FIG. 30 and FIG. 31, it is also possible to compose each of the upper chord members 71 and the lower chord members 72 by hollow members and to install the hubs 73 on the bottom faces of the upper chord members 71 and on the top faces of the lower chord members 72. FIG. 30 is a cross section view taken along the line Y4-Y4 of FIG. 31.

In the staircase according to the fifth embodiment, the

upper chord members 71 and the lower chord members 72 composing the truss structural members 70 are each composed of a single long-sized member having a length to cover the whole length of the truss structural members 70, and hubs 73 are installed on the bottom faces of the upper chord members 71 and on the top faces of the lower chord members 72. In addition, on the top faces of the upper chord members 71 are provided linking members 65, and in the present embodiment, the hubs 73, the upper chord members 71, and the linking members 65 are fixed integrally.

The upper chord members 71, in the present embodiment, are hollow extrusions of aluminum alloy, and as shown in FIG. 30, have a rectangular cross section. Inside the upper chord members 71 are formed separating boards 71a and 71a in the vertical direction. The upper chord members 71 are very lightweight because of being hollow inside, and the presence of the separating boards 71a and 71a inside provides a cross sectional structure strong against the vertical load and axial compression applied to the upper chord members 71.

The lower chord members 72, in the present embodiment, are hollow extrusions of aluminum alloy, and have the same cross sectional shape as the upper chord members 71, although their illustration is omitted. The other structures will not be described in detail here because they are the same as those in the staircase of the fourth embodiment.

When the hubs 73 are installed on the bottom faces of the upper chord members 71, as shown in FIG. 30, bolts B are

inserted from the bottom faces of the hubs 73 through the upper chord members 71 up to the inside of the linking members 65, and fastened with nuts N. Although it is not illustrated, when the hubs 73 are installed on the top faces of the lower chord members 72, bolts can be inserted from the top faces of the hubs 73 to the bottom faces of the lower chord members 72, and be fastened with nuts.

Thus, when the hubs 73 are installed on the bottom faces of the upper chord members 71 and the top faces of the lower chord members 72, the inner shapes of the upper chord members 71 and the lower chord members 72 can be determined in accordance with the load and other requirements.

In the present embodiment, both the upper chord members 71 and the lower chord members 72 are made long enough to cover the whole length of the truss structural members 70; however, it is also possible to make one of them long enough to cover the whole length of the truss structural members 70 and to compose the other by short-sized frame members linked via node members (hubs) as shown in the second embodiment.

<Sixth Embodiment>

The staircase according to a sixth embodiment of the present invention, as shown in FIG. 32 through FIG. 36, is composed of truss structural members 80 and 80 which are a pair of right and left stringers; a plurality of linking members 83 for linking the stringers; treads 66 which are fixedly supported on the linking members 83; handrails 15 which are

located above the side end parts of the treads 66; and balusters 13 for supporting the handrails 15. In the present embodiment, as shown in FIG. 32, between the bottom ends of the truss structural members 80 and the floor face 7 lower floor are disposed support shoes 85a and 85b, and between the top ends of the truss structural members 80 and the beam member 8a upper floor are disposed support shoes 85c.

The truss structural members 80, as shown in FIG. 32 and FIG. 33, are each composed of an upper chord member 1 and a lower chord member 2 which are inclined with the slope of the staircase; and a plurality of lattice members 4 for linking them. The upper chord member 1 and the lower chord member 2 are each composed of a plurality of frame members 3 linked to each other via hubs 5. Along the upper chord members 1 are provided upper reinforcing members 81, and along the lower chord members 2 are provided lower reinforcing members 82.

The structures of the frame members 3, the lattice members 4, the hubs 5, the balusters 13, and the handrails 15 and the method for joining them will not be described in detail here because they are the same as those described in the first embodiment.

The upper reinforcing members 81 are extrusions of aluminum alloy, and as shown in FIG. 32, have the same length as the whole length of the upper chord members 1. As shown in FIG. 34(a), the cross sectional shape of the upper reinforcing members 81 is groove shaped having an opened bottom face so as to include the upper chord members 1 (See FIG. 33). To be

more specific, the upper reinforcing members 81 are each composed of a top plate 81a located on the top face side of the upper chord members 1, and side plates 81b and 81b extending downwards from the side end parts of the top plates 81a so as to cover the upper chord members 1 (frame members 3), the top plates 81a being in contact with the top faces of the hubs 5.

The lower reinforcing members 82 are flat-shaped plate members made of aluminum alloy, and in the present embodiment, as shown in FIG. 32, have the same length as the portions of the lower chord members 2 that are in parallel with the upper chord members 1.

The linking members 83 are hollow extrusions of aluminum alloy having a polygonal cross section, and are each composed of an inclined face (hereinafter referred to as the attachment face 83b) which is inclined with the slope of the staircase and which is in contact with the top face of the upper reinforcing member 81, and a horizontal face on which the one of the treads 66 is placed (hereinafter referred to as the tread placing face 83a), and are each fixed on the top face of the upper reinforcing member 81 in the hub 5 area. In other words, the linking members 83 are laid between the right and left upper chord members 1 and 1 which are linked to each other via the linking members 83. As shown in FIG. 34(b), on the top faces inside the linking members 83 are formed nut pockets 83c for accommodating the nuts to fix the treads 66, and on the top faces and side faces inside the linking members 83 are formed screw pockets 83d. Into the screw pockets 83d are screwed for installing cap plates

84 (See FIG. 33) for covering the openings of the end faces of the linking members 83. The nut pockets 83c and the screw pockets 83d are formed when the linking members are extruded.

The upper reinforcing members 81 can be fixed to the hubs 5 by covering the upper reinforcing members 81 from the top of the upper chord members 1 (See FIG. 35(a) and FIG. 35(b)); disposing the linking members 83 on the top faces of the upper reinforcing members 81 (See FIG. 36); and inserting the bolts from the bottom faces of the hubs 5 to penetrate the upper reinforcing members 81 up to inside the linking members 83, and fixing them with the nuts. At this time, the linking members 83 are fixedly supported on the top faces of the upper reinforcing members 81. The lower reinforcing members 82 are fixed by screwing bolts which have been penetrated up to the top faces of the hubs 5 from their lower side with the nuts. Furthermore, the lower reinforcing members 82 come into contact with the bottom faces of the hubs 5 composing the lower chord members 2 so as to prevent the pulling out of the frame members 3 and the lattice members 4 in the downward direction.

Thus integrating the plurality of hubs 5 composing the upper chord members 1 with the upper reinforcing members 81 can improve the flexural rigidity of the truss structural members 80 in the out-of-plane direction, thereby greatly reducing the development of rolling when people are going up and down the staircase. When the staircase is viewed from the side, the upper chord members 1 are covered with the side plates 81b of the upper reinforcing members 81, which provides a simplified

appearance.

The truss structural members of each of the aforementioned embodiments have high rigidity against the load in the in-plane direction (vertical direction), but have comparatively low rigidity against the load in the out-of-plane direction (side-to-side direction). For this reason, in a staircase with supplementary means such as stringers, the right and left truss structural members composing the stringers are linked to each other via linking members or the treads to improve the rigidity against the out-of-plane direction. However, the truss structural members 80 according to the present embodiment have improved rigidity in the out-of-plane direction, which enables the linking members 83 to be composed of lighter weight members.

The cross sectional shapes of the upper reinforcing members 81 and the lower reinforcing members 82 are not restricted to the one shown in FIG. 34(a) and can be L-shaped as shown in FIG. 37(a), for example. By shaping the upper reinforcing members 81 and the lower reinforcing members 82 like the letter L or a groove, the frame members 3 composing the upper chord members 1 or the lower chord members 2 are concealed, making the design simple and also improving the rigidity in the vertical direction. When the upper reinforcing members 81 or the lower reinforcing members 82 are flat-shaped, there are clearances between these reinforcing members and the frame members 3; however, in the case of the L- or groove-shaped members, the clearances can be hidden, thereby improving the design.

As shown in FIG. 37(b), the upper reinforcing members 81 can be exclusively disposed without using the lower reinforcing members 82. In this case, the right and left lower chord members 2 and 2 can be linked to each other via the linking frame members 9. Although it is not illustrated, the lower reinforcing members 82 can be exclusively disposed without using the upper reinforcing members 81.

Although it is not illustrated, the truss structural members having the same structure as the aforementioned truss structural members 80 can be utilized as various structural members including architectural structural members, beside the stringers of staircases. To be more specific, in the truss structural members in which the upper and lower chord members are each composed of a plurality of frame members linked to each other via hubs, disposing reinforcing members along the chord members and fixing each of the reinforcing members to at least three hubs can integrate the plurality of hubs composing the chord members with the reinforcing members, whereby at least the intermediate hubs are reinforced in the direction that rotates the hubs. This improves the flexural rigidity of the truss structural members in the out-of-plane direction, and reduces deformation in the out-of-plane direction. Furthermore, the use of the reinforcing members extending across the whole length of the chord members as in the present embodiment can provide reinforcement throughout the length.

Therefore, for example, when a plurality of truss structural members are used together, the members to link

adjacent truss structural members can be omitted or made lighter in weight, thereby providing a simplified appearance. This can be applied to the truss structural members provided with so-called ball joint type nodes, besides the truss structural members utilizing hubs as in the present embodiment.

<Seventh Embodiment>

The staircase according to a seventh embodiment of the present invention, as shown in FIG. 38, has an intermediate reinforcing member 91 fixedly provided on the bottom faces of the plurality of linking members 83 for linking the truss structural members 90 and 90 which are a pair of right and left stringers. To be more specific, the plurality of linking members 83 adjacent in the height direction are integrated by being linked to each other via the intermediate reinforcing member 91.

The intermediate reinforcing member 91 is a flat-shaped plate member made of aluminum alloy, and is preferably long enough to integrate the linking members 83 from the lowermost through the uppermost. The intermediate reinforcing member 91 is fixed by contacting its top face with the attachment faces 83b of the linking members 83 (See FIG. 34(b)) and screwing drill screws from the bottom face side. The intermediate reinforcing member 91 can be a synthetic resin plate such as a polycarbonate plate or an acrylic resin plate, instead of the flat-shaped aluminum alloy plate.

Thus integrating the plurality of linking members 83 with

the intermediate reinforcing member 91 having a flat shape and high strength the side-to-side direction makes it possible that when the load the side-to-side direction is applied to one of the linking members 83 (treads 66), the load is received by the intermediate reinforcing member 91 without being totally transferred to the truss structural members 90 which are the stringers, and is then dispersed to the other linking members 83. This greatly reduces the development of twisting or rolling when people are going up and down the staircase, and makes the linking members 83 lighter in weight.

<Eighth Embodiment>

The staircase according to an eighth embodiment of the present invention, as shown in FIG. 39, has a board member 96 between a pair of right and left truss structural members 95 and 95.

The board member 96, in the present embodiment, is a board member having a number of small holes, and is fixed on the top faces of the plurality of hubs 5 composing the upper chord members 1. The board member 96 could also be a polycarbonate board, an acrylic resin board, an aluminum alloy board, or the like.

Thus providing the board member 96 between the right and left upper chord members 1 and 1 can integrate the right and left truss structural members 95 and 95, and reduce shearing deformation on the plane formed by the upper chord members 1 and 1, thereby greatly reducing the development of twisting or rolling when people are going up and down the staircase.

The board member 96 can be applied either across the whole length of the upper chord members 1 or a part of it. For example, as shown in FIG. 40, fixing a board member 96′ onto adjacent two hubs 5 on the right and on the left (four in total) can reduce shearing deformation on the plane formed by the four hubs 5, thereby greatly reducing the development of twisting or rolling when people are going up and down the staircase.

In the staircase shown in FIG. 39, the board member 96 is disposed between the right and left upper chord members 1 and 1; however, instead of this, it can be disposed between the right and left lower chord members 2 and 2, or both between the upper chord members 1 and 1 and between the lower chord members 2 and 2.

The truss structural members illustrated in the first to seventh embodiments are all single Warren trusses; however, instead of this, they can be Pratt trusses or Howe trusses.

The node members, which are column-shaped hubs 5 in the present embodiment, can be square column-shaped or other shaped, or have a ball-joint type node structure. Furthermore, the lattice members and the frame members can be joined by bolts or welding.

<Ninth embodiment>

As shown in FIG. 41, the staircase according to this embodiment comprises, as main parts, a pair of right and left truss structural members 100 and 100 inclining with the slope of the staircase, and a plurality of treads 160 disposed between

the truss structural members 100 and 100. Between treads 160 and 160 adjacent to each other, a riser 165 is attached. In FIG. 41, the handrails are omitted.

The truss structural member 100 is, as shown in FIG. 42, a so-called warren truss, comprising an upper chord member 110 and a lower chord member 120 inclining with the slope of the staircase, and a plurality of lattice members 130 linking the upper chord member 110 and the lower chord member 120 to each other. In this embodiment, the upper chord member 110 and the lower chord member 120 are inclined by 45 degrees, and the lattice members 130 are set so as to be inclined by 45 degrees with respect to the upper chord member 110 and the lower chord member 120. Therefore, in this embodiment, the horizontal lattice members 130 and the vertical lattice members 130 are disposed alternately. The slope of the staircase is not limited to 45 degrees, and as a matter of course, it is appropriately changeable according to installation conditions.

Furthermore, in this embodiment, support shoes 140 and 140 are interposed between the truss structural members 100 and the building skeleton K, and likewise, support shoes 140 and 140 are also interposed between the upper ends of the truss structural members 100 and the building skeleton K.

The upper chord member 110 has, as shown in FIG. 43(a), a plurality of column-shaped upper node members (hereinafter, referred to as upper hubs 111) provided in range with each other at predetermined intervals in the direction of the staircase inclination, upper frame members 112 that are short in length

and provided between the upper hubs 111 and 111 adjacent in the direction of the staircase inclination, and an upper through member 113 having a long length. Namely, the upper chord member 110 comprises one long-length upper through member 113, a plurality of short-length frame members 112 provided in series along the upper through member 113, and upper hubs 111 that link the upper frame members 112 adjacent to each other in the direction of the staircase inclination.

The lower chord member 120 has, as shown in FIG. 43(a), a plurality of column-shaped lower node members (hereinafter, referred to as lower hubs 121) provided in series in the direction of the staircase inclination, short-length lower frame members 122 disposed between the lower hubs 121 and 121 adjacent to each other in the direction of the staircase inclination, and a long-length lower through member 123. Namely, the lower chord member 120 comprises one long-length lower through member 123, a plurality of short-length lower frame members 122 linked along the lower through member 123, and lower hubs 121 which link the lower frame members 122 adjacent to each other in the direction of the staircase inclination.

In this embodiment, the difference in height between the upper hubs 111 and 111 adjacent to each other in the direction of the staircase inclination and the difference in height between the lower hubs 121 and 121 adjacent to each other in the direction of the staircase inclination are the heights of the risers. As shown in FIG. 43(a), the upper hub 111 and the lower hub 121 adjacent to each other in the cross direction of the staircase

are disposed at the same height.

The upper hub 111 is, as shown in FIG. 44(a), a short column with a circular cross section formed of an aluminum alloy-made extruded member. On the outer circumferential face of the upper hub 111, five linking grooves 111a are formed to be concave along the axis C1 of the upper hub 111, and at the center of the upper hub 111, a bolt insertion hole 111b is formed along the axis C1. The width of the upper hub 111 is the same as that of the linking end part 112a of the upper frame member 112 described later.

The linking grooves 111a of the upper hub 111 are formed radially around the bolt insertion hole 111b, and the central angle of the adjacent linking grooves 111a and 11a is 45 degrees. Furthermore, on the inner walls of the linking grooves 111a, notches are formed. The linking grooves 111a and the bolt insertion hole 111b are formed when the aluminum alloy is extruded. The form of the upper hub 111 and the number and the arrangement of linking grooves 111a are not limited to those of this embodiment, and are changeable as appropriate according to the slope of the staircase.

Furthermore, the upper hub 111 is disposed so that, as shown in FIG. 43(b), the axis C thereof is orthogonal to the truss plane T (plane formed by the upper chord member 110 and the lower chord member 120) of the truss structural member 100, as a result, the linking grooves 111a and the bolt insertion hole 111b (see FIG. 44(a)) of the upper hub 111 are orthogonal to the axis of the upper chord member 110 and the axis of the

lattice members 130. For example, in the side view shown in FIG. 43(a), the axis C1 of the upper hub 111 becomes vertical to the surface of the document paper.

Furthermore, as shown in FIG. 45, in the linking grooves to which the upper frame member 112 are not linked among the linking grooves 111a, groove filling members 111f having the same dimensions and shapes as those of the linking grooves 111a are fitted (inserted) for the purpose of improvement in appearance and prevention of accumulation of dust.

Detailed description of the lower hubs 121 is omitted since they have the same structure as that of the upper hubs 111 (see FIG. 44(a) and FIG. 44(b)).

The upper frame member 112 is formed by processing a hollow extruded member with a circular cross section made of an aluminum alloy, and as shown in FIG. 46(a), on both ends thereof, flat-shaped linking end parts 112a are provided. The linking end parts 112a are formed by pressing both ends of the hollow extruded member flat by a pressing machine, etc.

The linking end parts 112a of the upper frame members 112 can be fitted into the linking grooves 111a (see FIG. 44(a)) of the upper hubs 111, and as shown in FIG. 46(b), at their tip ends, notches to be engaged with the notches of the inner walls of the linking grooves 111a are formed in the direction orthogonal to the axis C2. The tip ends of the linking end parts 112a are cut along the direction orthogonal to the axis C2.

To link the upper frame members 112 to the upper hubs 111, as shown in FIG. 44(a), the linking end parts 112a of the

upper frame members 112 are fitted (inserted) into the linking grooves 111a from the end face side of the upper hubs 111. This work does not require welding or special tools, thereby providing high workability. Furthermore, in order to fill in the fine clearances created between the linking grooves 111a and the linking end parts 112a, it is also possible to pour glue or the like into the linking grooves 111a.

When the linking end parts 112a of the upper frame members 112 are fitted into the linking grooves 111a of the upper hubs 111, as shown in FIG. 45, notches formed on the linking grooves 111a and the linking end parts 112a are engaged with each other, which prevents the upper frame members 112 from being pulled out in the axis direction.

In addition, as shown in FIG. 46(b), since the linking end parts 112a of the upper frame members 112 are orthogonal to the axis C2, when the linking end parts 112a are fitted into the linking grooves 111a (see FIG. 44(a)) of the upper hub 111, the axis C2 of the upper frame members 112 and the axis C1 of the upper hubs 111 are orthogonal to each other. Furthermore, since the linking end parts 112a are formed to be flat and long in the direction of the axis C1 of the upper hub 111, a joint structure strong in strength against the external force in the direction of the axis C1 of the upper hub 111, that is, the external force in the side-to-side direction of the staircase is formed.

Detailed description of the lower frame members 122 is omitted since their structure is the same as that of the upper

frame members 112 (see FIG. 46(a) and FIG. 46(b)).

Since the upper hubs 111 and the lower hubs 121 are disposed so that the axes C1 thereof are orthogonal to the truss planes T (see FIG. 43(b)), so that even in a case where the staircase has a slope different from that of this embodiment, the linking grooves 111a of the upper hubs 111 and the linking grooves 121a of the lower hubs 121 (see FIGs. 44) always are orthogonal to the axes of the upper frame members 112 and the lower frame members 122. Namely, both ends of the upper frame members 112 and the lower frame members 122 are cut along the direction orthogonal to the axes thereof regardless of the slope of the staircase (see FIG. 46(b)), and since it is not necessary to change the angles of both ends of the upper frame members 112 and the lower frame members 122 according to the slope of the staircase, the staircase becomes suitable for mass production and high in productivity.

The upper through member 113 is an extruded member made of an aluminum alloy, and in this embodiment, its length is from the upper end to the lower end of the upper chord members 110 (see FIG. 42). In addition, as shown in FIG. 47(b), the upper through member 113 has a groove shape the bottom face of which opens, which can house the upper hubs 111 and the upper frame members 112. In greater detail, the upper through member 113 is composed of a pair of right and left side plates 113a and 113a to come into contact with both side end faces of the upper hubs 111, and an upper plate 113b that links the upper ends of the side plates 113a and 113a.

In addition, as shown in FIG. 47(a) and FIG. 47(b), the upper through member 113 is fixed to the side end faces of the upper hubs 111. To fix the upper through member 113 to the upper hubs 111, the upper through member 113 is covered on the upper hubs 111 from above (see FIGs. 49), bolts B11 are inserted into the bolt insertion holes 111b (see FIG. 44(a)) of the upper hubs 111 from the side plate 113a side of the upper through member 113, and the bolts B11 projecting to the side plates 113a on the opposite side are fastened by nuts N11. To the bolts B11 and nuts N11 projecting out of the upper through member 113, cap members 181 for improvement in appearance are attached.

The lower through member 123 is an extruded member made of an aluminum alloy, and in this embodiment, its length is from the upper end to the lower end of the lower chord member 120 (see FIG. 42). In greater detail, as shown in FIG. 47(b), the lower through member 123 is composed of a side plate 123a that comes into contact with the side end faces of the inner side of the lower hubs 121, and a lower plate 123b projecting downward below the lower hubs 121 from the lower end of the side plate 123a, and has an L-shaped cross section.

Furthermore, as shown in FIG. 47(a) and FIG. 47(b), the lower through member 123 is fixed to the side end faces of the inner sides of the lower hubs 121. To fix the lower through member 123 to the lower hubs 121, the lower plate 123b is positioned below the lower hubs 121 while the side plate 123a is made to contact with the inner side faces of the lower hubs 121, bolts B11 are inserted into the bolt insertion holes 121b

(see FIG. 44(b)) of the lower hubs 121 from the side of the side plate 123a of the lower through member 123, and the bolts B11 projecting to the side end faces on the outsides of the lower hubs 121 are fastened by nuts N11. To the bolts B11 and the nuts N11 projecting from the lower hubs 121, cap members 181 for improvement in appearance are attached.

The shapes of the upper through member 113 and the lower through member 123 are not limited to those illustrated as long as they can be attached to the side end faces of the upper hubs 111 and the side end faces of the lower hubs 121, and for example, the shapes may be flat although their illustration is omitted.

The lattice member 130 is formed by processing hollow extruded members with a circular cross section made of an aluminum alloy, which is the same type member as that of the upper frame member 112 shown in FIG. 46(a). Namely, the lattice member 130 has, on its both ends, flat-shaped linking end parts 130a (see FIG. 45) that can be fitted into the linking grooves 111a of the upper hubs 111 and the linking grooves 121a of the lower hubs 121 (see FIGs. 44), and on their tip ends, notches to be engaged with the notches on the inner walls of the linking grooves 111a are formed in the direction orthogonal to the axis. Furthermore, in the same manner as in the upper frame members 112 shown in FIG. 46(a), both ends of the lattice member 130 are cut along the direction orthogonal to its axis. Therefore, when the linking end parts 130a of the lattice members 130 are fitted into the linking grooves 111a of the upper hubs 111 or the linking grooves 121a of the lower hubs 121 (see FIGs. 44),

the axes of the lattice members 130 and the axes of the hubs 111 and 121 are orthogonal to each other.

Since the upper hubs 111 and the lower hubs 121 are disposed so that their axes C1 are orthogonal to the truss planes T (see FIG. 43(b)), even in a case where the staircase has a slope different from that of this embodiment, the linking grooves 111a of the upper hubs 111 and the linking grooves 121a of the lower hubs 121 always are orthogonal to the axes of the lattice members 130. Namely, both ends of the lattice members 130 are cut along the direction orthogonal to their axes regardless of the slope of the staircase, and since it is not necessary to change the angles of the end parts of the lattice members 130 according to the slope of the staircase, the staircase becomes suitable for mass production and high in productivity.

The support shoes 140 are formed of extruded members made of an aluminum alloy, and as shown in FIG. 48(a), FIG. 48(b), and FIG. 48(c), each have a base plate 141 to come into contact with the building skeleton K, and a pair of projecting plates 142 and 142 projecting from this base plate 141. The space between the projecting plates 142 and 142 is set so as to enable the upper chord member 110 or the lower chord member 120 to be inserted inside as shown in FIG. 48(b) and FIG. 48(c), and is equal to the width of the upper through member 113.

To attach the support shoes 140 to the upper and lower ends of the upper chord member 110, as shown in FIG. 48(b), the end part of the upper chord member 110 is inserted between the projecting plates 142 and 142 of the support shoe 140, and

bolt insertion holes (not shown) formed in the projecting plates 142 and the bolt insertion holes 111b of the upper hubs 111 are aligned with each other (see FIG. 44(a)), and thereafter, the bolt B13 is inserted from the side of one of the projecting plates 142 and the bolt B13 projecting from the other projecting plate 142 is fastened by a nut N13. The method for attaching the support shoes 140 to the upper and lower ends of the lower chord member 120 is the same, and in this case, a spacer 158 is interposed between the projecting plates 142 of the support shoe 140 and the side end face of the lower hub 121(see FIG. 48(c)).

In this embodiment, as shown in FIGs. 47 and FIG. 50, tread receiving members 150 for attaching the treads 160 to the side faces of the upper chord member 110 and the lower chord member 120 are provided side by side at predetermined intervals.

The tread receiving member 150 comprises, as shown in FIG. 47(a) and FIG. 47(b), a fixed plate 151 that comes into contact with the side face (side plate 113a) of the upper through member 113 or the side face (side plate 123a) of the lower through member 123 and a supporting plate 152 that projects inward from the upper end of the fixed plate 151, and has an L-shaped section.

When the upper hubs 111 and the upper through member 113 are fixed, the tread receiving members 150 of the upper chord member 110 are actually attached together. In greater detail, when the upper hub 111 and the upper through member 113 are fixed, the fixed plate 151 of the tread receiving members 150 is made to contact with the side plate 113a of the upper through

member 113 and fastened to the upper hub 111 together with the upper through member 113 by a bolt B1 and a nut N11 (see FIG. 47(a) and FIG. 47(b)). Namely, the tread receiving members 150 are fixed to the side end faces of the upper hubs 111 together with the upper through member 113. Likewise, the tread receiving members 150 of the lower chord member 120 side are fixed to the side end faces of the lower hubs 121 together with the lower through member 123.

In this embodiment, the tread 160 comprises, as shown in FIG. 50, a plate member 161 that is rectangular in its plan view and joint members 162 and 162 attached to both side end parts of the plate member 161.

As a material of the plate member 161, any material such as wood or metal can be used as long as it has a quality and structure with rigidity and strength that withstands for a bending moment developing at its center due to a vertical load.

The joint member 162 is formed of an extruded member made of an aluminum alloy, and comprises, as shown in FIG. 47(b), a side contact plate 162a to come into contact with the side end face of the plate member 161, a lower contact plate 162b that projects along the back face of the plate member 161 from the lower end of this side contact plate 162a, and a projecting plate 162c that projects horizontally outward from the side face of the side contact plate 162a. The length of the joint member 162 is determined so as to be across the tread receiving member 150 attached to the upper hub 111 and the tread receiving member 150 attached to the lower hub 121 adjacent horizontally

to the upper hub 111. The joint member 162 is fixed to the plate member 161 by driving drill screws not shown from the lower contact plate 162b.

To attach the treads 160 to the truss structural members 100, as shown in FIG. 47(a) and FIG. 47(b), the projecting plates 162c of the joint members 162 are placed on the top faces of the supporting plates 152 of the tread receiving members 150, and the supporting plates 152 and the projecting plates 162c are fixed by bolts B12 and nuts N12.

The handrails (copings) 171 and balusters 172 supporting the handrails 171 are not limited to those shown in FIG. 42. Namely, the handrails 171 and balusters 172 are not structures that support the staircase itself, so that various forms, designs, and materials can be freely selected for them.

The balusters 172 are attached by using the upper hubs 111 and the lower hubs 121. Attachment by using the side plate 123a of the lower through member 123 (see FIG. 47(b)) is also possible.

Procedures for constructing the staircase according to this embodiment are described with reference to FIG. 42 through FIG. 45 and FIGs. 49 through FIG. 50.

To construct the staircase according to this embodiment, as shown in FIG. 50, two truss structural members 100 formed into a unit are attached in advance to the building skeleton K interspatially, treads 160 are attached between the right and left truss structural members 100 and 100, and furthermore, the balusters 172 and the handrails 171 (see FIG. 42) are attached

as appropriate.

To form the truss structural members 100 into units, first, as shown in FIG. 49(a), the plurality of upper hubs 111 are arranged in range with each other at predetermined intervals, and the upper hubs 111 and 111 adjacent to each other are linked in order by the upper frame members 112, and likewise, the plurality of lower hubs 121 are arranged in range with each other at predetermined intervals, and the lower hubs 121 and 121 adjacent to each other are linked in order by the lower frame members 122. To link the upper hubs 111 and the upper frame members 112, as shown in FIG. 44(a), the linking end parts 112a of the upper frame members 112 are fitted into the linking grooves 111a of the upper hubs 111, and to link the lower hubs 121 and the lower frame members 122, as shown in FIG. 44(b), the linking end parts 122a of the lower frame members 122 are fitted into the linking grooves 121a of the lower hubs 121.

Next, the upper hubs 111 and the lower hubs 121 are linked to each other by lattice members 130 (see FIG. 49(a)). Namely, as shown in FIGs. 43 through FIG. 45, the linking end part 130a on one side of the lattice member 130 is fitted into a linking groove 111a positioned adjacent to the linking groove 111a which the upper frame member 112 has been joined to among the five linking grooves 111a of the upper hub 111, and the other linking end part 130a is fitted into the linking groove 121a positioned adjacent to the linking groove 121a which the lower frame member 122 has been joined to among the five linking grooves 121a of the lower hub 121. At this point, since five linking grooves

111a of the upper hub 111 and the five linking grooves 121a of the lower hub 121 are each arranged at 45-degree pitches (see FIGs. 44), the lattice member 130 is inclined at 45 degrees with respect to the upper frame member 112 and the lower frame member 123.

Next, as shown in FIG. 49(a) and FIG. 49(b), the upper through member 113 is covered from above the upper hubs 111 and the upper frame member 112, and the tread receiving materials 150 are disposed to be the same in a position as that of the upper hub 111, and the upper hub 111, the upper through member 113, and the tread receiving member 150 are integrally fixed by the bolt B1 and the nut N11.

The plurality of upper hubs 111 are integrated by the upper through member 113 and the rotation of the upper hubs 111 around their axes are restrained, as a result, the weak axis directions of the truss structural members 100, that is, the strength in the vertical direction of the staircase is reinforced. Namely, the bending rigidity in the in-plane direction of the truss structural members 100 is improved.

Likewise, the lower through member 123 is disposed along the lower hubs 121 and the lower frame members 122, the tread receiving members 150 are set on the side end faces of the lower hubs 121, and the lower hubs 121, the lower through member 123, and the tread receiving members 150 are fixed integrally by bolts B11 and nuts N11. At this point, to the side end faces on the outer sides of the lower hubs 121, washers 121d are attached for preventing the lower frame members 122 and the lattice

members 130 from slipping outward (see FIG. 44(b)).

The plurality of lower hubs 121 are integrated by the lower through member 123 and the rotation of the lower hubs 121 around their axes are restrained, as a result, the strength in the weak axis direction of the truss structural members 100 is reinforced. Namely, the bending rigidity in the in-plane direction of the truss structural members 100 is improved by the lower through members 123.

In addition, as shown in FIG. 49(b), support shoes 140 are attached to each of the upper and lower ends of the upper chord members 110 and the upper and lower ends of the lower chord members 120.

As described above, the assembling of the truss structural members 100 does not require welding or special tools, so that the assembling becomes easy and the number of parts for linking can be reduced, thereby providing economic efficiency.

Furthermore, since the upper hubs 111 and the lower hubs 121 are arranged so that their axes are orthogonal to the truss planes, the out-of-plane direction of the truss structural members 100, that is, the side-to-side direction of the staircase in this embodiment becomes the strong axis direction, and the truss structural members 100 have high strength against external forces and deformation applied from the right or left.

Furthermore, when the truss structural members 100 are assembled up to the status mentioned above, the frame members 112 and 122 and the lattice members 130 are prevented from slipping out in the side-to-side directions of the hubs 111

and 121. Namely, even when the truss structural members 100 are manufactured in advance at a factory, etc., and are transported to an installation site, the members of the truss structural members 100 do not slip out, and in addition, they can be transported while the plurality of truss structural members 100 are piled up, thereby providing high transportation efficiency.

It is also possible that the treads 160 are attached to the truss structural members 100 and 100 at a factory (that is, in the status shown in FIG. 41). In this case, construction of the staircase is completed only by installing this unit to the building skeleton K.

As described above, according to the staircase of this embodiment, unlike conventional staircases that support the treads by massive members made of channel steel or I-shaped steel, the treads 160 are supported by the truss structural members 100 that have a lightweight structure and a sense of lightness in weight, thereby providing a sense of openness, and even when the staircase is installed indoors, it provides no sense of oppression. Furthermore, the side end parts of the treads 160 are fixed to the side end faces of the upper hubs 111 and the side end faces of the lower hubs 121, so that when this staircase is viewed from the side, as shown in FIG. 42 and FIGs. 43, the side end faces of the treads 160 are positioned within the side faces of the truss structural members 100, and this provides a very simple appearance.

Furthermore, the truss structural members 100 are

structured so that the side end parts of the treads 160 are fixed to the side end faces of the upper hubs 111 and the side end faces of the lower hubs 121, as a result, the upper chord members 110 and the lower chord members 120 are linked to each other by the treads 160 (see FIGs. 43). Namely, since the upper chord members 110 and the lower chord members 120 are tightly integrated with each other by the lattice members 130 and the treads 160, the rigidity of the truss structural members 100 becomes very high. Furthermore, between the right and left truss structural members 100 and 100, the upper hubs 111 are linked to each other and the lower hubs 121 are linked to each other by the treads 160, so that displacement and deformation of the upper hubs 111 and the lower hubs 121 in the out-of-plane directions of the truss planes are restricted. Namely, between the right and left truss structural members 100 and 100, the upper chord members 110 are linked to each other and the lower chord members 120 are linked to each other by the treads 160 (see FIG. 41), and shearing deformation of the plane formed by the right and left upper chord members 110 and 110 and the plane formed by the right and left lower chord members 120 and 120 is restrained, as a result, the development of twisting and rolling when people go up and down the staircase are greatly reduced.

Furthermore, the upper hubs 111 and the lower hubs 121 are formed of identical members, and the upper frame members 112 and the lower frame members 122 are formed of identical members, so that the number of parts is small and productivity

is high.

The truss structural members 100 of the staircase shown in FIG. 41 through FIG. 50 have upper through members 113 in the upper chord members 110, and have lower through members 123 in the lower chord members 120, however, like in the truss structural member 100 of the staircase shown in FIG. 51, it is also possible that the upper chord member 110 comprises a plurality of short-length upper frame members 112 provided in series in the direction of the staircase inclination and the upper hubs 111 that link the upper frame members 112 adjacent to each other in the direction of the staircase inclination, and the lower chord member 120 comprises a plurality of short-length lower frame members 122 provided in series in the direction of the staircase inclination and lower hubs 121 that link the lower frame members 122 adjacent to each other in the direction of the staircase inclination.

Such a structure makes it possible to easily adjust the lengths of the upper chord members 110 and the lower chord members 120. Namely, to change the number of treads, the numbers of upper frame members 112 and the lower frame members 122 are only changed.

Furthermore, like in the truss structural member 100 shown in FIG. 52(a), it is also possible that the upper chord member 110 comprises a plurality of upper hubs 111 provided in series in the direction of the staircase inclination and a long-length upper through member 113 fixed to the upper hubs, and the lower chord member 120 comprises a plurality of lower hubs 121 provided

in series in the direction of the staircase inclination and a long-length lower through member 123 fixed to the lower hubs. In addition, it is also possible that, as shown in FIG. 52(b), a hollow part 113c is formed in the upper through member 113 and a hollow part 123c is formed in the lower through member 123 to increase the strength.

Such a structure makes it easy to manufacture the truss structural member since the number of parts forming the truss structural member 100 is reduced.

Furthermore, it is also possible that, for example, the upper chord member 110 comprises an upper through member 113 and a plurality of upper hubs 111 and the lower chord member 120 comprises a plurality of lower frame members 122 and lower hubs 121 that link the lower frame members although their illustration is omitted. These can be properly determined in consideration of the strength and design, etc., required for the staircase.

In addition, the tread receiving members 150 of each of the staircases shown in FIG. 41 through FIGs. 52 are attached for each hub, however, like the tread receiving members 150 of the staircase shown in FIG. 53(a) and FIG. 53(b), it is also possible that the tread receiving members 150 are laid across the upper hubs 111 and the lower hubs 121 adjacent to each other in the cross direction. In this case, the tread receiving members 150 have lengths that enable them to be laid across the upper hubs 111 and the lower hubs 121 adjacent to each other in the cross direction, and are fixed to the side end faces of the

upper hubs 111 and the side end faces of the lower hubs 121.

Furthermore, the treads 160 of the staircases shown in FIG. 41 through FIGs. 52 are attached to the tread receiving members 150 via the joint members 162, however, the structure is not limited to this, and it is also possible that, like the treads 160 of the staircase shown in FIG. 53(a) and FIG. 53(b), the plate members 161 are directly attached to the top faces of the tread receiving members 150.

Such a structure makes it easy to manufacture the staircase since the number of parts forming the staircase is reduced, since the upper hubs 111 and the lower hubs 121 are linked to each other by the tread receiving members 150, the strength of the truss structural members 100 is increased.

Furthermore, in each of the staircases shown in FIG. 41 through FIGs. 52, the treads 160 are attached via the tread receiving members 150 attached to the side end faces of the hubs, however, the structure of the tread receiving members 150 is not limited to this, and for example, like the tread receiving members 150′ shown in FIG. 54(a), it is also possible that the tread receiving member 150 comprises a front side horizontal member 155 laid between the upper hubs 111 and 111 adjacent in the side-to-side direction, and a rear side horizontal member 156 laid between the lower hubs 121 and 121 adjacent in the side-to-side direction. In this case, the treads 160 are fixed to the top faces of the front side horizontal members 155 and the top faces of the rear side horizontal members 156.

Herein, the front side horizontal member 155 is a hollow extruded member with a rectangular section, and both ends thereof are externally fitted to receiving pieces 157 and 157 fixed to the side end faces of the right and left upper hubs 111 and 111, whereby the front side horizontal member 155 is fixed to the side end face of the upper hub 111. Likewise, the rear side horizontal member 156 is a hollow extruded member with a rectangular section, and both ends thereof are externally fitted to receiving pieces 157 and 157 fixed to the side end faces of the right and left lower hubs 111 and 111, whereby the rear side horizontal member 156 is fixed to the side end face of the lower hub 121. Furthermore, the receiving pieces 157 of the upper chord member 110 side are fixed to the side end faces of the upper hubs 111 together with the upper through member 113, and likewise, the receiving pieces 157 of the lower chord member 120 side are fixed to the side end faces of the lower hubs 121 together with the lower through member 123.

In such a structure, since the tread 160 is supported by the front side horizontal member 155 laid between the right and left upper chord members 110 and 110 and the rear side horizontal member 156 laid between the right and left lower chord members 120 and 120, the flexure at the center of the tread 160 is reduced. Namely, since the strength of the tread 160 itself can be low, the degree of freedom in structure and material selection of the tread 160 increases.

Furthermore, like the treads 160 shown in FIG. 55(a) and FIG. 55(b), it is also possible that the tread 160 itself is

formed of a hollow extruded member, and both ends thereof are directly externally fitted to and fixed to the receiving pieces 157 and 157. Namely, it is possible that the side end parts of the tread 160 are directly fixed to the side end face of the upper hub 111 and the side end face of the lower hub 121.

In such a structure, the number of parts forming the staircase is reduced, so that manufacturing becomes easy.

When a staircase with a slope of an angle other than 45 degrees is constructed, the arrangement of the linking grooves is changed in each hub. Namely, among the linking grooves 111a of the upper hub 111 (see FIG. 45), the angles between the linking grooves 111a to which the lattice members 130 are linked and the linking grooves 111a to which the upper frame members 112 are linked are set to be equal to the angle of the slope of the staircase. For example, when the slope of the staircase is 40 degrees, the angle between the linking grooves 111a and 111a is set to 40 degrees.

Furthermore, as shown in FIG. 56, it is possible to cope with changes in the slope of the staircase by making the heights of the tread receiving members 150 to be attached to the upper hubs 111 different from the heights of the tread receiving members 150 to be attached to the lower hubs 121. In this case, by adjusting the axis directions of the lattice members 130 by folding the tip parts of the lattice members 130 toward predetermined directions, the treads 160 and the lattice members 130 become parallel to each other when the staircase is seen from the side.

<Tenth Embodiment>

The staircase according to the tenth embodiment of the present invention will be described with reference to FIG. 57 through FIG. 68.

First, the entire structure of the staircase according to the tenth embodiment will be described with reference to FIG. 57 through FIG. 60.

FIG. 57 is a perspective view of the staircase as a whole according to the tenth embodiment of the present invention, FIG. 58 is a front view of the same, FIG. 59 is a side view of the same, and FIG. 60 is an enlarged view of FIG. 59.

As shown in FIG. 57 through FIG. 60, the staircase according to the tenth embodiment of the present invention has a space truss structural member 210 as an intermediate stringer, and is mainly composed of the space truss structural member 210 inclined with the slope of the staircase; a plurality of brackets 206 disposed at each riser height; and treads 207 supported by the space truss structural member 210 via the brackets 206. As shown in FIG. 59 and FIG. 60, the space truss structural member 210 is fixed on the floor face F1 lower floor via the support shoes S1 and S2 attached at its bottom end, and fixed on the beam member F21 supporting the floor face F2 upper floor via the support shoes S3 attached on its top end. In addition, in the present embodiment, the side ends of the treads 207 are fixed on the wall face W, and a handrail 209 is provided on the other side ends.

Next, the space truss structural member will be described with reference to FIG. 61 through FIG. 65.

FIG. 61 is an exploded perspective view of the staircase according to the tenth embodiment of the present invention, FIG 62(a) is a view seen from the direction of the arrows X1-X1 of FIG. 59; FIG. 62(b) is a view seen from the direction of the arrows X2-X2 of FIG. 59; FIG. 63 is a view to show the frame members, the linking frame members, and the lattice members; FIG. 64 is an exploded perspective view to show the state of assembling the hubs as the node members, and the frame members and the linking frame members to be joined with the hubs; and FIG. 65 is a plan view of the same.

The space truss structural member 210, as shown in FIG. 61 and FIG. 62, is composed of two parallel upper chord members 210A and 210A; frame-shaped linking frame members 203 for linking the upper chord members 210A and 210A with each other; a single lower chord member 210B disposed below the midpoint between the upper chord members 210A and 210A; and lattice members 204 for linking the upper chord members 210A and 210A with the lower chord member 210B.

The upper chord members 210A and 210A are each composed of a plurality of frame members 201 linked to each other via hubs 202A which are node members, and the lower chord member 210B is composed of a plurality of frame members 201 linked to each other via hubs 202B. Thus, the plurality of frame members 201 can be linked together in the longitudinal direction to compose the upper chord members 210A.

Since the hubs 202A composing the upper chord members 210A and the hubs 202B composing the lower chord member 210B have the same structure, these hubs are referred with "202" in the description common to both of them.

The frame members 201 are made by processing hollow extrusions of aluminum alloy with a circular cross section, and as shown in FIG. 63 (a) and FIG. 63(b) are each provided with flat-shaped linking end parts 201a on both ends.

The linking end parts 201a of the frame members 201 are formed by applying press working or the like to both ends of the hollow extrusions, and can be fit into the linking grooves 202a (See FIG. 64) of the hubs 202 described later. The linking end parts 201a, as shown in FIG. 63(b), have notches at their tips in the direction orthogonal to the axis of the frame members 201. Since they are long flattened in the axial direction of the hubs 202 (See FIG. 64), the linking end parts 201a have a joint structure strong against the external force in the axial direction of the hubs 202.

The hubs 202, as shown in FIG. 64, are column-shaped, and are each provided with a plurality of linking grooves 202a carved on their outer surface along the axial direction of the hubs 202, and with a bolt insertion hole 202b formed in the center on the end face. The hubs 202 are extrusions of aluminum alloy, and the linking grooves 202a and the bolt insertion holes 202b are formed when the aluminum alloy is extruded. It is also possible to form the hubs 202 by casting.

The linking grooves 202a of the hubs 202, as shown in

FIG. 65, have the same cross sectional shape as the tip parts of the linking end parts 201a of the frame members 201 so as to be engaged with the linking end parts 201a. On the inner walls of the linking grooves 202a are provided with notches which are supposed to be engaged with the notches of the linking end parts 201a. In the present embodiment, eight linking grooves 202a are formed radially, and adjacent linking grooves 202a form a center angle of 45 degrees; however, it is possible to change the shape of the hubs 202, the number of linking grooves 202a and the like in accordance with the number and angle of the members to be joined with the hubs 202.

As shown in FIG. 64, of the linking grooves 202a, those which are not joined with the frame members 201, the linking frame members 203, or the lattice members 204 are filled with groove-filling members 202e having the same size and shape as the linking grooves 202a. In the present embodiment, the length of the linking grooves 202a of the hubs 202 is matched with the length (width) of the linking end parts 204a of the lattice members 204, and therefore, for example, when the frame members 201 are inserted down to the bottom ends of the hubs 202, there are clearances in the above portions in the grooves 202a. In this case, groove-filling members 202f are inserted above the linking end parts 201a of the frame members 201 so as to prevent the dislocation of the frame members 201 joined.

When the frame members 201 are joined with the hubs 202, the notches formed on the linking end parts 201a of the frame members 201 can be fit into the linking groove 202a from the

top face side (or the bottom face side) of the hubs 202. At this time, no welding or special tools are required, thereby providing high in workability. In order to fill in the fine clearances developed between the linking grooves 202a and the linking end parts 201a, it is also possible to pour glue or the like into the linking grooves 202a.

When the linking end parts 201a of the frame members 201 are fit into the linking grooves 202a of the hubs 202, as shown in FIG. 65, the notches formed on each of the linking grooves 202a and the linking end parts 63a are engaged with each other, which prevents the frame members 201 from being pulled out in the axial direction.

In addition, on the top and bottom faces of the hubs 202B composing the lower chord member 210B are fixed washers 202d so as to prevent the frame members 201 and the lattice members 204 from being pulled out. The washers 202d are fixed with through bolts B17 which are inserted into the bolt insertion holes 202b of the hubs 202B, and nuts N17. On the top and bottom faces of the hubs 202B are attached caps 202c for covering the bolts B17 and the nuts N17.

On the other hand, the hubs 202A composing the upper chord members 210A are provided with brackets 206 on their top faces (See FIG. 60), and the washers 202d are attached exclusively on the bottom faces.

The linking frame members 203, like the frame members 201 shown in FIG. 63(a) and FIG. 63(b), are made by processing hollow extrusions of aluminum alloy, and have flat-shaped

linking end parts 203a at their both ends. The linking end parts 203a have notches at their tips which have the same cross sectional shape as the linking end parts 201a of the frame members 201 so as to be fit into the linking grooves 202a of the hubs 202.

Like the frame members 201, the lattice members 204 are made by processing hollow extrusions of aluminum alloy, and as shown in FIG. 63(c) and FIG. 63(d), have flat-shaped linking end parts 204a at their both ends. The linking end parts 204a have notches at their tips in the direction which forms an angle α (hereinafter referred to as the coin angle α) with respect to the axis of the lattice members 204. The linking end parts 204a have the same cross sectional shape as the linking end parts 201a of the frame members 201 so as to be press fit into the linking grooves 202a of the hubs 202. The lattice members 204 are joined with the hubs 202 in such a manner that their axial direction has an inclination of the coin angle α with respect to the axial direction of the hubs 202.

FIG. 66(a) is a cross sectional view taken along the line X3-X3 of FIG. 59; FIG. 66(b) is a view seen from the direction of the arrows X4-X4 of FIG. 59 (the space truss structural member is seen from the direction of the slope of the staircase, and the brackets and treads are seen from the direction of the front of the staircase); FIG. 67(a) is a perspective view of the bracket; and FIG. 67 (b) is a side view of the same.

The brackets 206 installed on the upper chord members 210A and 210A are hollow extrusions of aluminum alloy with a

polygonal cross section, and as shown in FIG. 67(a) and FIG. 67(b), are provided with tread supporting faces 206a to support the treads 207 on their top faces, and the attachment faces 206b on their bottom faces, which are laid on the top faces of the hubs 202A of the upper chord members 210A.

The attachment faces 206b are inclined with the slope of the staircase with respect to the tread supporting faces 206a. In other words, when the attachment faces 206b are laid on the top faces of the hubs 202A, the tread supporting faces 206a become horizontal (See FIG. 60).

The openings of the brackets 206 are closed by the lid members 206c (See FIG. 60).

In the present embodiment, as shown in FIG. 66(b), adjacent upper chord members 210A and 210A are linked to each other via the brackets 206.

The treads 207 are plate members made of wood or metal, and as shown in FIG. 66(a) and FIG. 66(b), are fixedly supported on the tread supporting faces 206 of the brackets 206. In the present embodiment, there are plates 207a buried inside the treads 207 to screw the bolts B16.

FIG. 68 (a), FIG. 68(b), and FIG. 68(c) are side views of the support shoes.

The support shoes S1, as shown in FIG. 68(a), are each composed of a floor contact face S11 which comes into contact with the floor face F1 lower floor; a hub contact face S12 which comes into contact with the bottom face of the hub 202A; and a locking piece S13 for positioning and fixing the hub 202A.

As shown in FIG. 60, the support shoes S1 are disposed between the bottom faces of the lowermost hubs 202A of the upper chord members 210A and the floor face F1 lower floor. The hub contact faces S12 are inclined with the slope of the staircase with respect to the floor contact faces S11.

The support shoe S2, as shown in FIG. 68(b), is composed of a floor contact face S21 which comes into contact with the floor face F1 lower floor; a hub contact face S22 which comes into contact with the bottom face of the hub 202B; and a locking piece S23 for positioning and fixing the hub 202B. As shown in FIG. 60, the support shoe S2 is disposed between the bottom face of the lowermost hub 202B of the lower chord member 210B and the floor face F1 lower floor. The hub contact face S22 is inclined with the slope of the staircase with respect to the floor contact face S21.

The support shoes S3, as shown in FIG. 68(c), are each composed of a beam contact face S31 which comes into contact with the side face of the beam member F21 supporting the floor face upper floor; a hub contact face S22 which comes into contact with the bottom face of the hub 202A; and a locking piece S33 for positioning and fixing the hub 202A. As shown in FIG. 60, the support shoes S3 are each disposed between the bottom face of the uppermost hub 202A of the upper chord member 210A and the side face of the beam member F21. The hub contact faces S22 are inclined with the slope of the staircase with respect to the beam contact faces S31.

The support shoes S1 and S2, and S3 are extrusions of

aluminum alloy. The shapes of these support shoes are not restricted to those illustrated, and can be modified according to the situation of the installing site of the staircase.

The constructing process of the staircase according to the tenth embodiment of the present invention will be described with reference to FIG. 59 through FIG. 62, FIG. 64, and FIG. 66.

First, the constructing process of the space truss structural member 210 will be described as follows. The space truss structural member 210, as shown in FIG. 61, can be constructed by joining the frame members 201, the linking frame members 203, and the lattice members 204 with the hubs 202A, and joining the frame members 201 and the lattice members 204 with the hubs 202B.

With reference to FIG. 62(a) and FIG. 62(b), the constructing process of the space truss structural member 210 will be described in detail. First, four of the lattice members 204 are joined with one of the hubs 202B composing the lower chord member 210B at a pitch of 90 degrees. At this time, the lattice members 204 are joined with the hubs 202 in such a manner that they are inclined by the coin angle α with respect to the axis of the hubs 202B because the linking end parts 204a of the lattice members 204 form the coin angle α (See FIG. 63(d)). After preparing a plurality of such units and aligning them, the frame members 201 are sequentially joined with adjacent hubs 202B and 202B so as to compose the lower chord member 210B. Furthermore, the upper ends of the adjacent lattice members

204 and 204 are linked to each other via the hubs 202A. Then, the frame members 201 are joined with the hubs 202A, 202A adjacent in the axial direction to compose the upper chord members 210A, and the frame members 203 are joined with the hubs 202A, 202A adjacent in the direction orthogonal to the axis, thereby linking the two upper chord members, 210A and 210A with each other.

As a result of this assembly, the lower chord member 210B is located blow the midpoint between the upper chord members 210A and 210A, which makes the space truss structural member 210 look like an inverted triangle when viewed in the axial direction (See FIG. 66(b)). When the space truss structural member 210 is viewed from the side, it looks like a Warren truss (See FIG. 59).

As the result of the assembly, the axes of the hubs 202A and the axes of the hubs 202B orthogonally cross the axes of the frame 1. In other words, the axes of the hubs 202A orthogonally cross the upper chord members 210A, and the axes of the hubs 202B orthogonally cross the lower chord members 210B. Thus, the hubs 202A and the hubs 202B are arranged in such a manner that their linking grooves 202a and the bolt insertion holes 202b (See FIG. 64) are orthogonal to the direction of the slope of the staircase. The end faces of the hubs 202A and the hubs 202B are inclined with the slope of the staircase.

In addition, the assembling process of the space truss structural member 210 can be modified, without being restricted to the one described before.

After the space truss structural member 210 is constructed, as shown in FIG. 60, the brackets 206 are laid on the top faces of the hubs 202A of the upper chord members 210A, and the through bolts B15 are inserted into the bolt insertion holes 202b from the bottom face side of the hubs 202A, so as to fix the brackets 206 on the top faces of the hubs 202A. On the bottom face side of the hubs 202A are attached washers 202d (See FIG. 64) for preventing pulling out.

As shown in FIG. 64, the washers 202d for preventing the pulling out of the frame members 201 and the lattice members 204 are applied on the top and bottom faces of the hubs 202B of the lower chord member 210B and fixed with the through bolts B17 and the nuts N17. In addition, the through bolts B17 and the nuts N17 are covered with caps 202c.

Next, the space truss structural member 210 is laid between the floor board F1 lower floor and the beam member F21 upper floor (See FIG. 59). In this case, between the bottom faces of the hubs 202A located at the bottom end of the upper chord members 210A and the floor face F1 lower floor are disposed support shoes S1, and between the bottom face of the lowermost hub 202B located at the lower chord member 210B and the floor face F1 lower floor is disposed a support shoe S2, respectively, and between the uppermost hubs 202A of the upper chord members 210A and the beam member F21 upper floor are disposed support shoes S3.

When the space truss structural member 210 is laid at a prescribed staircase slope, the tread supporting faces 206a

of the brackets 206 become horizontal.

Then, the treads 207 are laid on the tread supporting faces 206a, and the bolts B16 are screwed into the plates 207a which are buried in the treads 207 from inside the brackets 206, thereby fixing the brackets 206 and the treads 207. When necessary, as shown in FIG. 66(a) and FIG. 66(b), side ends of the treads 207 are fixed to the receiving members 208 installed on the wall face W.

Finally, the handrail 209 is installed on the side ends of the treads 207 to complete the constructing of the staircase.

The aforementioned constructing process of the staircase is one example and can be modified. The space truss structural member 210 can be assembled either in the factory beforehand, or at the installing site of the staircase. In either case, the space truss structural member can be constructed easily and accurately only by assembling the aforementioned members which have been previously formed to have the prescribed shapes and sizes.

Thus, staircases can be constructed only by fitting or bolt joining the members which have been formed in the prescribed sizes and shapes. This is because no complicated process is necessary at a building site, and no special tools or welding is necessary, which enables unskilled workers to construct staircases. In addition, the number of components for linking can be reduced, which is economical.

Furthermore, using the space truss structural member 210 as the intermediate stringer makes the staircase lighter in

weight than conventional staircases which use heavy members such as channel steel or I-shaped steel, thereby facilitating handling during construction. In particular, making the space truss structural member 210 and the brackets 206 of an aluminum alloy can realize the constructing of a lighter-weight staircase because of the advantages of aluminum alloy which is lightweight for its strength and is not corrosive. Therefore, such a staircase can be used with the floor structure of conventional wooden houses.

It is also possible to easily control the length of the staircase as a whole (the number of steps) by increasing or decreasing the number of frame members 201 to be linked in the upper chord members 210A and the lower chord member 210B. When the staircase slope is different, all that must be done is to replace the brackets 206 with those matching the staircase slope. Thus, staircases having a different number of steps or slopes can be constructed without changing the sizes or shapes of the frame members 201, the hubs 202, the linking frame members 203, and the lattice members 204, that is, the respective members to compose the space truss structural member 210 can be mass manufactured so as to improve production efficiency.

Since they are supported in the center parts, the treads 207 develop minor flexure. Fixing the side ends of the treads 207 at the wall face W as in the present embodiment further stabilizes the treads 207, and the presence of the wall face W on a side of the treads 207 gives pedestrians on the staircase a sense of safety.

The space truss structural member 210 is composed of the two upper chord members 210A and the single lower chord member 201B, which forms an inverted triangle (See FIG. 66(b)) when viewed from the direction of the slope of the staircase, providing a simplified appearance. Furthermore, the truss structure provides a sense of lightness in weight and openness, without obstructing the field of vision more than necessary, thereby creating a bright and clean indoor space with no sense of oppression. In addition, the space truss structural member 210 is prevented from locating above the treads 207 because the brackets 206 are fixed on the top faces of the upper chord member 210A and 210A of the space truss structural member 210, and the treads 207 are fixedly supported on the top faces of the brackets 206, which provides a simplified appearance. Therefore, for example, as shown in FIG. 57, when the staircase according to the present embodiment is constructed along the wall face W, the wall face and the truss structural member 210 do not overlap with each other above the treads 207, which maintains the appearance of the staircase.

Since the displacement and deformation the side-to-side direction of the upper chord members 210A and 210A of the space truss structural member 210 are restrained by the linking frame members 203, the torsional rigidity of the entire staircase and the flexural rigidity the side-to-side direction are improved, which greatly reduces the development of twisting or rolling of the staircase when people are going up and down the staircase.

<Eleventh Embodiment>

The staircase according to an eleventh embodiment of the present invention will be described in detail with reference to FIG. 69 through FIG. 72. The same components as those in the staircase according to the tenth embodiment are referred to with the same reference symbols, and the overlapping description will be omitted.

FIG. 69 is an exploded perspective view of the staircase according to the eleventh embodiment of the present invention; FIG. 70(a) is a plan view to show the arrangement of the upper chord members and the linking frame members of the space truss structural member composing the staircase according to the second embodiment of the present invention; FIG. 70(b) is a plan view to show the arrangement of the lower chord member and the lattice members of the same; FIG. 70(c) is a side view of the space truss structural member; FIG. 71 is a side view of the staircase according to the first embodiment of the present invention; and FIG. 72 is an enlarged view of FIG. 71. FIG. 70(a) is a view seen from the direction of the arrows X5-X5 of FIG. 71, and FIG. 70(b) is a view seen from the direction of the arrows X6-X6 of FIG. 71.

As shown in FIG. 69 through FIG. 72, the staircase according to the eleventh embodiment of the present invention has a space truss structural member 220 as an intermediate stringer, and is composed of the space truss structural member 220 inclined with the slope of the staircase; a plurality of brackets 206

disposed at each riser height; and treads 207 supported by the space truss structural member 220 via the brackets 206. As shown in FIG. 71 and FIG. 72, the space truss structural member 220 is fixed on the floor face F1 lower floor via the support shoes S1 and S2 attached at its bottom end, and fixed on the beam member F21 supporting the floor face F2 upper floor via the support shoes S3 attached on its top end. In the present embodiment, there are handrails 209 on both the right and left side ends. The brackets 206, the treads 207, and the handrails 209 have the same structures as those described in the tenth embodiment, so a detailed description will be omitted.

The space truss structural member 220, as shown in FIG. 69 and FIG. 70, is composed of two parallel upper chord members 220A and 220A; linking frame members 203 and linking diagonal members 205 for linking the upper chord members 220A and 220A with each other; a single lower chord member 220B located below the midpoint of the upper chord members 220A and 220A; and lattice members 204 for linking the upper chord members 220A and 220A and the lower chord member 220B together.

The upper cord members 220A and 220A are each composed of a plurality of frame members 201 linked via hubs 222A which are node members, whereas the lower chord member 220B is composed of a plurality of frame members 210 linked via hubs 222B. The frame members 201, the linking frame members 203, and the lattice members 204 have the same structures as those described in the tenth embodiment, so a detailed description will be omitted.

The linking diagonal members 205 like the frame members

201 shown in FIG. 63(a) and FIG. 63(b), are made by processing hollow extrusions of aluminum alloy, and have flat-shaped linking end parts at their both ends. The linking end parts have notches at their tips which have the same cross sectional shape as the linking end parts 201a of the frame members 201 so as to be fit into the linking grooves of the hubs 222A. The linking frame members 203 are orthogonal to the upper chord members 220A and 220A, whereas the linking diagonal members 205 are diagonal to the upper chord members 220A and 220A. To be more specific, as shown in FIG. 70(a), on the top face of the space truss structural member 220 are formed rectangular frame bodies by the frame members 201 composing the upper chord members 220A and the linking frame members 203 linking the right and left upper chord members 220A. And the linking diagonal members 205 are arranged on the diagonals of the frame bodies in a staggered arrangement, thereby forming a truss on the top face of the space truss structural member 220 in cooperation with the upper chord members 220A and 220A, and the linking frame members 203.

The hubs 222A and 222B have the same structure as the hubs 202 shown in FIG. 64 except that linking grooves (having the same structure as the linking grooves 202a described in the tenth embodiment) are formed on their outer surface exclusively in the directions that join the frame members 201, the linking frame members 203, the lattice members 204 or the linking diagonal members 205. Such a structure can prevent unused linking grooves from being exposed so as to make the

groove-filling members 202e (See FIG. 64) unnecessary, which provides a simplified appearance.

As shown in FIG. 70(a) and FIG. 70(b), the lattice members 204 and the linking diagonal members 205 are arranged in the same direction in a plan view; in this case, the hubs 222A composing the upper chord members 220A are made long-sized (See FIG. 70(c)), and the lattice members 204 and the linking diagonal members 205 are sequentially joined in the same linking grooves.

Thus disposing the linking diagonal members 205 on the diagonals of the frame bodies formed by the frame members 201 and the linking frame member 203 on the top face of the space truss structural member 220 can greatly improve the torsional rigidity and the flexural rigidity (particularly the side-to-side direction) of the space truss structural member 220, which greatly reduces the shearing deformation of these frame bodies. Thus, it becomes possible to greatly reduce the development of twisting or rolling of the staircase when an unbalanced load is applied while people are going up and down the staircase.

As shown in FIG. 72, the space truss structural member 220 is fixed on the floor face F1 lower floor via the support shoes S1 and S2 attached at its bottom end, and fixed on the beam member F21 supporting the floor face F2 upper floor via the support shoes S3 attached on its top end. The support shoes S1 and S2, and S3 shown in FIG. 72 are different in the whole shape from the support shoes shown in FIG. 68; however, the main parts have the same structure.

To be more specific, the support shoes S1 are each composed of a hub contact face which comes into contact with the bottom face of the hub 222A, and a floor contact face which comes into contact with the floor face F1 lower floor; and the support shoe S2 is composed of a hub contact face which comes into contact with the bottom face of the hub 222B, and a floor contact face which comes into contact with the floor face F1 lower floor. And the support shoes S3 are each composed of a hub contact face which comes into contact with the bottom face of the hub 222A, and a beam contact face which comes into contact with the side face of the beam member F21 supporting the floor face upper floor. These hub contact faces are inclined with the slope of the staircase.

The staircase according to the eleventh embodiment described hereinbefore, similar to the staircase according to the tenth embodiment, has a simplified appearance, thereby providing a sense of lightness in weight and openness without obstructing the field of vision more than necessary, which results in a bright and clean indoor space with no sense of oppression. Furthermore, the torsional rigidity of and the flexural rigidity the side-to-side direction are high, thereby producing no twisting or rolling of the staircase when people are going up and down the staircase is slight. In other words, the stability of the treads 207 can be secured only by the space truss structural member 220, without fixing the treads 207 on the wall face, which enables the staircase to be installed in a desired site.

When the brackets 206 are regarded as structural members, it is possible to dispense with the linking frame members 203 and to link the upper chord members 220A and 220A with each other via the linking diagonal members 205 only.

In the aforementioned embodiments, the space truss structural member is composed of two upper chord members and a single lower chord member linked to each other via the lattice members. However, the number of upper chord members and the number of lower chord members are not restricted to these; as shown in a twelfth embodiment which will be described later, the space truss structural member can be composed of a larger number of upper chord members and lower chord members.

<Twelfth embodiment>

The staircase according to a twelfth embodiment of the invention is described in detail with reference to FIG. 73 and FIG. 74. The same elements as those of the staircases according to the embodiments described above are attached with the same symbols, and overlapping description will be omitted.

Herein, FIG. 73 is an exploded perspective view of the staircase according to the twelfth embodiment of the invention, and FIG. 74 shows a view of the space truss structural member of the staircase shown in FIG. 73 seen from the direction of the staircase inclination and the brackets and the treads seen from the staircase front side.

The staircase according to the twelfth embodiment of the invention comprises, as shown in FIG. 73, a space truss

structural member 230 inclining with the slope of the staircase, a plurality of brackets 231 disposed at each of the heights of the risers, and treads 207 supported by the space truss structural member 230 via the brackets 231. The space truss structural member 230 is fixed to the floor face of the lower floor via support shoes attached to the lower ends of the truss structural member (see FIG. 68(a) and FIG. 68(b)), and are fixed to beam members supporting the floor face of the upper floor via support shoes (see FIG. 68(c)) attached to the upper end of the truss structural member. In addition, as shown in FIG. 74, in this embodiment, the side ends of the treads 207 are fixed to the wall face W, and the other side ends are attached with a handrail 209. The treads 207 and the handrail 209 are structured similarly to those described in the tenth embodiment, so that a detailed description thereof is omitted. In addition, it is possible that the treads are not fixed to the wall face W and this applies to the above-described embodiments.

The space truss structural member 230 comprises, as shown in FIG. 73 and FIG. 74, three upper chord members 230A parallel to each other, lower chord members 230B positioned below the midpoints of adjacent ones of the upper chord members 230A and 230A, linking frame members 203 that link the adjacent upper chord members 230A to each other and link the adjacent lower chord members 230B, and lattice members 204 that link the upper chord members 230A and the lower chord members 230B to each other.

Namely, the space truss structural member 230 has three

upper chord members 230A and two lower chord members 230B, and as shown in FIG. 74, it is roughly trapezoid when seen from the direction of the staircase inclination.

The upper chord member 230A comprises a plurality of frame members 201 linked to each other by hubs 202A, and the lower chord member 230B comprises a plurality of frame members 201 linked to each other by hubs 202B. The frame members 201, the hubs 202A and 202B, the linking frame members 203, and the lattice members 204 are structured similarly to those described in the tenth embodiment, so that a detailed description thereof is omitted.

The bracket 231 is structured similarly to the bracket 206 shown in FIGs. 67 except for a different length, so that a detailed description thereof is omitted.

When the space truss structural member 230 is thus structured, the treads 207 can be more stably supported than in the case of the space truss structural member 210 of the tenth embodiment.

Furthermore, to support treads wider than the treads 207, by linking more upper chord members 230A and lower chord members 230B to the sides of the upper chord members 230A and the lower chord members 230B, the treads are easily supported. Since the lower chord members 230B are positioned below the midpoints of adjacent ones of the upper chord members 230A, the number of lower chord members is always one less than the number of upper chord members 230A.

Furthermore, even when upper chord members of more than

three and lower chord members of more than two are used to form the space truss structural member, the simplified appearance is still obtained, thereby providing a sense of lightness in weight and openness without obstructing the field of vision more than necessary, which results in a bright and clean indoor space with no sense of oppression.

<Thirteenth embodiment>

The staircase according to the thirteenth embodiment of the invention is described in detail with reference to FIG. 75 and FIG. 76. The same elements as those of the staircases according to the above-described embodiments are attached with the same symbols, and overlapping description is omitted.

Herein, FIG. 75 shows a view of the space truss structural member of the staircase according to the thirteenth embodiment of the invention seen from the direction of the staircase inclination, and the brackets and the treads seen from the front side of the staircase, and FIG. 76 is a side view of the same.

As shown in FIG. 75 and FIG. 76, the staircase according to the thirteenth embodiment of the invention comprises a space truss structural member 240 inclining with the slope of the staircase, a plurality of brackets 231 disposed at each riser height, and treads 207 supported by the space truss structural member 240 via the brackets 231. Furthermore, the space truss structural member 240 is fixed to the floor face F1 of the lower floor via support shoes S1 and S2 attached to the lower end thereof, and are fixed to beam members F21 that support the

floor face F2 of the upper floor via support shoes S3 attached to the upper end. Furthermore, as shown in FIG. 75, in this embodiment, the side ends of the treads 207 are fixed to the wall face W, and the other side ends are attached with a handrail 209. Furthermore, the treads 207, the handrail 209, and the support shoes S1, S2, and S3 are structured in the same manner as those described in the tenth embodiment, so that a detailed description thereof is omitted.

The space truss structural member 240 comprises, as shown in FIG. 75 and FIG. 76, three upper chord members 240A parallel to each other, lower chord members 240B positioned below the midpoints of adjacent ones of the upper chord members 240A and 240A, linking frame members 203 that link the adjacent upper chord members 240A to each other and link the adjacent lower chord members 240B to each other, and lattice members 204 that link the upper chord members 240A and the lower chord members 240B to each other, and furthermore, at the midpoint of the upper floor face F2 and the lower floor face F1, a second lower chord member 240C is disposed below the midpoint of the adjacent lower chord members 240B and 240B, and the lower chord members 240B and 240B are linked to each other by the lattice members 204.

Namely, the space truss structural member 240 has three upper chord members 240A and two lower chord members 240B, and further has one second lower chord member 240C at the midpoint of the upper floor face F2 and the lower floor face F1.

The upper chord members 240A are formed of a plurality

of frame members 201 linked by the hubs 202A, the lower chord members 240B are formed of a plurality of frame members 201 linked by the hubs 42B, and the second lower chord member 240C is formed of a plurality of frame members 201 linked by the hubs 42C. In addition, the frame members 201, the hubs 202A, the linking frame members 203, and the lattice members 204 are structured in the same manner as those described in the tenth embodiment, so that a detailed description thereof is omitted.

The brackets 231 are structured similarly to the brackets 206 shown in FIGs. 67 except for a different length, so that a detailed description thereof is omitted.

The hubs 242B are structured similarly to the hubs 202 shown in FIG. 64, however, two lattice members 204 are linked to one linking groove, so that the lengths of the hubs 242B are longer than that of the hubs 202. In other points, their structure is similar to that of the hubs 202, so that a detailed description thereof is omitted. The hubs 242C are structured similarly to the hubs 202, so that a detailed description thereof is omitted.

Thus, according to the staircase of the thirteenth embodiment, the bending rigidity (in particular, in the vertical direction) of the space truss structural member 240 is improved by disposing the second lower chord member 240C below the midpoint of the lower chord members 240B and 240B. Therefore, flexure of the space truss structural member 240 is greatly restrained.

In addition, the space truss structural member 240 shown

in FIG. 75 has three upper chord members 240A, two lower chord members 240B, and one second lower chord member 240C, as a result, it has a shape of an inverted triangle, however, for example, when the number of upper chord members 240A is four, the number of lower chord members 240B becomes three and the number of second lower chord members 240C becomes two, so that the space truss structural member 240 becomes trapezoid although it is not shown. Furthermore, when the number of upper chord members 240A is two, the number of lower chord members 240B becomes one, so that only one second lower chord member 240C is provided immediately below the lower chord member 240B.

<Fourteenth embodiment>

The staircase according to the fourteenth embodiment of the invention is described in detail with reference to FIG. 77. The same elements as those of the staircases according to the above-described embodiments are attached with the same symbols, and overlapping description is omitted.

Herein, FIG. 77 is an exploded perspective view of the staircase according to the fourteenth embodiment of the invention.

The staircase according to the fourteenth embodiment is constructed by arranging a plate member 251 on the top face of the space truss structural member 210 of the staircase of the tenth embodiment described above and fixing this plate member 251 to a plurality of hubs 202A. Namely, the upper chord members 210A and 210A adjacent to each other are linked to each other

by the plate member 251.

The space truss structural member 210 is the same as that described in the tenth embodiment, so that a detailed description thereof is omitted.

The plate member 251 is formed of an aluminum alloy plate in which a number of small holes are perforated, and is fixed to the top faces of the plurality of hubs 202A forming the upper chord members 210A. The plate member 251 may be formed of a polycarbonate plate, an acrylic resin plate, or a wood plate.

According to the staircase of the fourteenth embodiment, the positional relationship of the plurality of hubs 202A is restricted by the plate member 251, as a result, shearing deformation of the plane (the top face of the space truss structural member 210) formed by the plurality of hubs 202A is restrained. Namely, by linking the right and left upper chord members 210A and 210A to each other by the plate member 251, the right and left upper chord members 210A and 210A are integrated, whereby shearing deformation of the top face of the space truss structural member 210 (plane formed by the upper chord members 210A and 210A) is restrained, as a result, the development of twisting and rolling on the space truss structural members 210 and 210 when people go up and down the staircase is greatly reduced.

Furthermore, since deformation of the top face of the space truss structural member 210 is restrained by the plate member 251, the structure of the linking frame members 203 and the brackets 206 can be lightened in weight. Furthermore, when

deformation of the top face of the space truss structural member 210 is sufficiently restrained only by the plate member 251, the linking frame members 203 can be omitted.

In addition, the plate members 251 can be attached across the whole length of the upper chord members 210A or attached to a part of the upper chord members. It is also possible that a plurality of plate members are arranged in a spaced manner in the direction of the staircase inclination although this is not illustrated.

<Fifteenth embodiment>

The staircase according to the fifteenth embodiment is described in detail with reference to FIGs. 78 through FIGs. 80. The same elements as those of the above-described embodiments are attached with the same symbols, and overlapping description thereof is omitted.

Herein, FIG. 78(a) and FIG. 78(b) are exploded perspective views of the staircase according to the fifteenth embodiment of the invention. In FIG. 78(a), the brackets and treads are omitted. FIG. 79(a) shows a view of the space truss structural member seen from the direction of the staircase inclination and the brackets and treads seen from the front side of the staircase (corresponding to the view seen from the direction of the arrows X4-X4 of FIG. 59). FIG. 79(b) shows a modified example of the staircase according to the fifteenth embodiment, and FIG. 80(a), FIG. 80(b), and FIG. 80(c) show modified examples of the same.

The staircase according to the fifteenth embodiment is constructed so that, as shown in FIGs. 78(a), upper reinforcing members 261A are arranged along the upper chord members 210A of the space truss structural member 210 of the staircase of the tenth embodiment described above and are fixed to serial three or more hubs 202A forming the upper chord member 210A, and lower reinforcing members 261B are arranged along the lower chord members 210B and are fixed to serial three or more hubs 202B forming the lower chord member 210B. Namely, along the upper chord members 210A and the lower chord members 210B, upper reinforcing members 261A and lower reinforcing members 261B are arranged so as to reinforce the strength in the weak axis direction of the linked parts of the hubs.

The space truss structural member 210 is the same as that described in the tenth embodiment, so that a detailed description thereof is omitted.

The upper reinforcing members 261A and the lower reinforcing members 261B are flat plates 261 (so-called flat bars) made of an aluminum alloy as shown in FIG. 78(a), and in this embodiment, they have the same lengths as the whole lengths of the upper chord members 210A and the lower chord members 210B, respectively. In the flat plate 261, a plurality of bolt holes are perforated according to the hubs 202A (hubs 202B).

The flat plate 261 does not always have high rigidity in the vertical direction (plate thickness direction), however, it has high rigidity in the side-to-side direction (width

direction), and therefore, the rigidity in the side-to-side direction of the upper chord members 210A and the lower chord members 210B can be sufficiently increased.

To fix the upper reinforcing members 261A (flat plate 261) to the top faces of the hubs 202A forming the upper chord members 210A, as shown in FIG. 78(a), the upper reinforcing members 261A are placed on the top faces of the hubs 202A, and as shown in FIG. 78(b), brackets 206 are placed on the top faces of the upper reinforcing members 261A, and then bolts (not shown) are inserted from the bottoms of the hubs 202A through the upper reinforcing members 261 to the insides of the brackets 206 and fastened by nuts (not shown). In this case, the brackets 206 are also supported and fixed onto the top faces of the upper reinforcing members 261A by the bolts and nuts.

In addition, to fix the lower reinforcing member 261B (flat plate 261) to the bottom faces of the hubs 202B forming the lower chord member 210B, as shown in FIG. 78(a), bolts (not shown) are inserted from the bottom faces to the top faces of the hubs 202B while the lower reinforcing member 261B is made to contact with the bottom faces of the hub 202B and are fastened by nuts (not shown). As shown in FIG. 79(a), when the lower reinforcing member 261B is disposed, the lower reinforcing member 261B comes into contact with the bottom faces of the hubs 202B and prevents the frame members 201 and the lattice members 204 from slipping downward, so that the washer 202d shown in FIG. 64 can be omitted.

According to the staircase of the fifteenth embodiment,

the plurality of hubs 202A forming the upper chord members 210A are integrated by the upper reinforcing members 261A, and the bending rigidity in the side-to-side direction (weak axis direction) of the upper chord members 210 is increased, as a result, rolling when people go up and down the staircase can be greatly reduced. Namely, by integrating at least three hubs 202A by the upper reinforcing member 261A, at least the middle hub 202A is reinforced in the direction of rotation around its axis, so that the bending rigidity of the upper chord members 210 in the side-to-side direction is increased, and deformation in the side-to-side direction is restrained.

In addition, since the bending rigidity of the lower chord members 210B in the side-to-side direction (weak axis direction) is also increased by the lower reinforcing member 261B, torsional rigidity of the truss structural member is increased, whereby twisting and rolling when people go up and down the staircase are greatly restrained.

Furthermore, as in this embodiment, by using the upper reinforcing members 261A having lengths across the whole lengths of the upper chord members 210A and the lower reinforcing member 261B having a length across the whole length of the lower chord member 210B, the space truss structural member 210 is reinforced across the whole length, and for example, it is possible that the structure of the linking frame members 203 and the brackets 206 is lightened in weight, and furthermore, it is also possible that the linking frame members 203 are omitted. In the case where the linking frame members 203 are omitted, like the space

truss structural member 210′ shown in FIG. 79(b), the right and left upper chord members 210A and 210A are linked to each other by the brackets 206.

The forms of the upper reinforcing members 261A and the lower reinforcing members 261B are not limited to those shown in FIG. 79(a) and FIG. 79(b).

For example, like the upper reinforcing members 261A shown in FIG. 80(a), the upper reinforcing members may be formed of members 262 each having an L-shaped section, and like the lower reinforcing member 261B, the lower reinforcing member may be formed of a member 263 having a groove-shaped section with a top face opened.

The member 262 having an L-shaped section is composed of an upper plate 262a arranged along the upper side of the upper chord member 210A, and a side plate 262b hung down from the side end part of the upper plate, and is shaped into an L in its section. In this case, the upper plate 262a contributes to improvement in rigidity in the side-to-side direction of the upper chord member 210A. Furthermore, the side plate 262b has a primary role to improve the design of the staircase side face by covering the side face of the upper chord member 210A as well as a role to improve the rigidity in the vertical direction of the upper chord member 210A. Namely, since the clearance between the frame member 201 and the upper plate 262a is covered by the side plate 262b, a simplified design is obtained.

The member 263 having a groove-shaped section is formed into a groove shape in its section by a lower plate 263 disposed

along the lower side of the lower chord member 210B and side plates 263b and 263b stood up along the inclination direction of the lattice member 204 from both side ends of the lower plate. In this case, the lower plate 263a contributes to improvement in rigidity in the side-to-side direction of the lower chord member 210B. In addition, the side plates 263b and 263b have a primary role to improve the design of the staircase side faces by covering the side faces of the lower chord member 210B as well as a role of improvement in rigidity in the side-to-side direction of the lower chord member 210B. Namely, since the clearance between the frame member 201 and the lower plate 263a is covered, a simplified design is obtained.

Furthermore, the above-described upper reinforcing members 261A and the lower reinforcing member 261B are provided mainly for improvement in rigidity in the side-to-side direction of the upper chord members 210A and the lower chord member 210B, and it is also possible that upward and downward loads are positively allotted to the reinforcing members 261A and 261B.

For example, as shown in FIG. 80(b), when the member 264 having a hollow part 264a is used as the upper reinforcing member 261A, the sectional properties of the member 264 are high, so that rigidity can be improved not only in the side-to-side direction but also in the vertical direction. Furthermore, as shown in FIG. 80(c), a member partially having a hollow part 265a may be disposed so that the hollow part 265a is positioned by the side of the upper chord member 210A (or the lower chord member 210B). Since the member 265 shown in FIG. 80(c) has a

hollow part 265a at the side, not only is the rigidity of the upper chord member 210A improved in the side-to-side direction and the vertical direction, but also the upper chord member 210A is covered by the hollow part 265a, so that a simplified design is obtained for the side face of the staircase.

Furthermore, it is preferable that the upper reinforcing members 261A and the lower reinforcing member 261B are provided across the whole lengths of the upper chord members 210A or the lower chord member 210B, however, in the case where each reinforcing member is composed of a plurality of short-length members, the short-length members are fixed to serial three or more hubs 202, and preferably, the continuous parts of the short-length members are overlapped on the hubs 202, and further preferably, the continuous parts are overlapped on serial two hubs 202. For example, in the case where the upper chord member 210A is composed of ten hubs 202A and nine frame members 201 (see FIG. 59) and the upper reinforcing member 261A is composed of two short-length members, it is preferable that each short-length member is formed into a length that makes it possible to fix the short-length member to the serial six hubs 202A, one short-length member is fixed to the six hubs 202A from below, and another short-length member is fixed to the six hubs 202A from above, and the end parts of the short-length members are overlapped on the serial two hubs 202A. Thereby, even when the upper reinforcing member 261A is composed of a plurality of short-length members, the reinforcing effect at the same level as in the case where the upper reinforcing member

261A is composed of one long-length member is obtained.

<Sixteenth embodiment>

The staircase according to the sixteenth embodiment of the invention is described in detail with reference to FIGs. 81 through FIGs. 83. The same elements as those of the above-described embodiments are attached with the same symbols, and overlapping description thereof is omitted.

Herein, FIG. 81(a) and FIG. 81(b) are exploded perspective views of the staircase according to the sixteenth embodiment of the invention. In FIG. 81(a), the brackets and treads are omitted. FIG. 82 is a side view of FIG. 81(b), and FIG. 83(a) is a view seen from the direction of the arrows X7-X7 of FIG. 82 (a view of the space truss structural member seen from the staircase inclination direction and the bracket and treads seen from the front side of the staircase). FIG. 83(b) and FIG. 83(c) show modified examples of the staircase according to the sixteenth embodiment.

The staircase according to the sixteenth embodiment comprises, as shown in FIG. 81(b) and FIG. 82, a space truss structural member 270 inclining with the slope of the staircase, a plurality of brackets 206 disposed at each riser height, and treads 207 supported by the space truss structural member 270 via the brackets 206.

The space truss structural member 270 comprises two upper chord members 270A and 270A parallel to each other, frame-shaped linking frame members 203 that link the upper chord members

270A and 270A to each other, one lower chord member 270B positioned below the midpoint of the upper chord members 270A and 270A, lattice members 204 that link the upper chord members 270A and 270A and the lower chord member 270B to each other.

The lower chord member 270B has the same structure as that of the lower chord member 210B of the staircase of the tenth embodiment, and the frame members 201, the hubs 202, the linking frame members 203, and the lattice members 204 are also identical to those described in the tenth embodiment, so that a detailed description thereof is omitted.

The upper chord member 270A is formed of a member 71 having a groove part 271a that opens at its side face of the lower chord member 270B side and the hubs 202A are housed inside the groove part 271a as shown in FIG. 81(a) and FIG. 83(a). Namely, in the staircase according to the tenth embodiment shown in FIG. 61, the upper chord member 210A is formed by providing a plurality of short-length frame members 201 in series in the lengthwise direction, however, in the staircase according to the sixteenth embodiment, the upper chord member 270A is formed of a long-length member 271. The hubs 202A are attached inside the member 271.

The member 271 is an extruded member made of an aluminum alloy, and as shown in FIG. 81(a), on the lower chord member 270B side, it has a groove part 271a whose face opposite the other upper chord member 270A is opened. The groove part 271a continues in the direction of the staircase inclination. In greater detail, as shown in FIG. 83(a), the member 271 is formed

of an upper plate 271c and a lower plate 271d, a side plate 271e linking the side ends of these upper and lower plates, and a partition plate 271f that links the midpoint of the upper plate 271c to the midpoint of the lower plate 271d. In addition, the groove part 271a is formed by the upper plate 271c, the lower plate 271d, and the partition plate 271f, and the hollow part 271b is formed by the upper plate 271c, the lower plate 271d, the side plate 271e, and the partition plate 271f. The member 271 is very light in weight since the inside is hollow, and furthermore, the upper plate 271c and the lower plate 271d are linked by the partition plate 271f at their midpoints, so that the sectional structure of the member is strong against vertical loads.

Next, the procedures for constructing the staircase according to the sixteenth embodiment are described with reference to FIG. 81(a) and FIG. 81(b).

First, four lattice members 204 are linked to the hubs 202B forming the lower chord member 270B at pitches of 90 degrees. In this case, since the linking end parts 204a of the lattice members 204 have the coin angle α (see FIG. 63(d)), the lattice members 204 are linked with an inclination of α with respect to the axes of the hubs 202B. After a plurality of units thus formed are assembled and arranged in range with each other, the frame members 201 are linked to adjacent hubs 202B and 202B in turn to form the lower chord member 210B, and the upper ends of the adjacent lattice members 204 and 204 are further linked by the hubs 202A.

Next, as shown in FIG. 81(a), the members 271 are covered on the plurality of hubs 202A from the sides, and the plurality of hubs 202A are housed inside the groove parts 271a of the members 271, whereby the upper chord members 270A are formed. In this case, the bolt insertion holes 202b of the hubs 202A (see FIG. 64) and the bolt insertion holes of the members 271 are aligned with each other.

Thereafter, as shown in FIG. 81(b), the brackets 206 are placed on the top faces of the upper chord members 270A (upper plates 271c of the members 271). Then, bolts (not shown) are inserted from the bottom face sides of the upper chord members 270A to the insides of the brackets 206 and fastened by nuts (not shown), whereby the hubs 202A, the members 271, and the brackets 206 are fixed integrally.

Then, this unit is carried to a staircase installation site, and the unit is installed so as to incline with a predetermined slope of the staircase, and thereafter, the treads 207 are supported and fixed onto the tread supporting faces 206a of the brackets 206 and handrails, etc., are arranged as appropriate, whereby construction is completed.

According to the staircase of the sixteenth embodiment, the upper chord members 270A are formed of the members 271 having groove parts 271a and the plurality of hubs 202A are housed inside the groove parts 271a, so that as shown in FIG. 82, the design of the side faces of the staircase is simplified. Furthermore, since the upper chord member 270A is formed of one long-length member 271, no weak axis exists. Namely, the

upper chord members 270A are high in rigidity not only in the vertical direction but also in the side-to-side direction, and therefore, a structure strong against rolling and twisting is obtained. As in the case of the above-described embodiments, the construction of the staircase does not require welding or special tools, thereby providing high workability.

In addition, the form of the member forming the upper chord member 270A is not limited to that described above, and for example, like the member 271′ shown in FIG. 83(b), it is possible that the hollow part 271b′ is formed to be trapezoid to improve the design.

Furthermore, in the space truss structural members 270 shown in FIG. 83(a) and FIG. 83(b), the hubs 202A are disposed so that their axes are orthogonal to the axes of the linking frame members 203, that is, the top and bottom faces of the hubs 202A incline with the slope of the staircase, however, like the hubs 202A′ of the truss structural members 270′ shown in FIG. 83(c), it is possible that their axes cross diagonally the axes of the linking frame members 203′. In this case, a member 272 that has, on the lower chord member 270B side, a groove part whose face opposite the lower chord member 270B is opened, is used.

Furthermore, as shown in FIG. 83(b) and FIG. 83(c), it is possible that the above-described lower reinforcing member 261B is disposed along the lower chord member 270B.

In addition, the forms of the hubs 202 described in the first through sixteenth embodiments are not limited to those

illustrated, and they may be formed into, for example, rectangular column shapes. The node members are not limited to the structures using the above-described hubs 202, and it is also possible that the ball joint method is employed.

<Seventeenth embodiment>

The staircase according to the seventeenth embodiment of the invention is described with reference to FIG. 84 through FIG. 86. The same elements as those of the above-described embodiments are attached with the same symbols, and overlapping description thereof is omitted.

Herein, FIG. 84 is a perspective view in which a part of the staircase of the seventeenth embodiment of the invention is omitted, FIG. 85(a) is a view of the space truss structural member of FIG. 84 seen from the direction of the staircase inclination, FIG. 85(b) is a side view of FIG. 84, FIG. 86 is a perspective view showing a linking frame member and a lattice member.

The staircase according to the seventeenth embodiment comprises, as shown in FIG. 84, a space truss structural member 280 inclining with the slope of the staircase, a plurality of brackets 206 disposed at each riser height, and treads 207 supported by the space truss structural member 280 via the brackets 206.

The space truss structural member 280 comprises two upper chord members 280A and 280A parallel to each other, linking frame members 283 that link the upper chord members 280A and

280A to each other, one lower chord member 280B positioned below the midpoint of the upper chord members 280A and 280A, and lattice members 284 that link the upper chord members 280A and 280A and the lower chord member 280B to each other.

The upper chord member 280A is formed of, as shown in FIG. 85(a), a member 281 that has a connection piece 281a projecting toward the lower chord member 280B and a connection piece 281b projecting toward the adjacent upper chord member 280A. The top face of the upper chord member 280A is formed to be flat (hereinafter, referred to as a bracket supporting face 281c). The member 281 is a hollow extruded member made of an aluminum alloy, and the connection pieces 281a and 281b are formed integrally when the aluminum alloy is extruded. In the connection pieces 281a and 281b, bolt insertion holes are perforated at proper intervals.

The lower chord member 280B is formed of, as shown in FIG. 85(a), a member 282 having two connection pieces 282a and 282a projecting toward the upper chord members 280A. The member 282 is a hollow extruded member made of an aluminum alloy, and the connection pieces 282a and 282a are formed integrally when the aluminum alloy is extruded.

The linking frame members 283 are frame-shaped as shown in FIG. 86, and are formed by processing a hollow extruded member with a circular section made of an aluminum alloy. Both ends thereof are pressed flat (hereinafter, referred to as flat end parts 283a). In the flat end parts 283a, bolt insertion holes 283b are perforated.

The lattice members 284 have the same structure as that of the linking frame members 283 described above, and have flat end parts 284a on both ends, and in the flat end parts 284a, bolt insertion holes 284b are perforated.

Next, construction procedures of the staircase according to the seventeenth embodiment are described with reference to FIG. 84 and FIGs. 85.

First, the members 281 forming the upper chord members 280A and the member 282 forming the lower chord member 280B are arranged and linked to each other by a plurality of lattice arranged zigzags. Namely, as shown in FIG. 85(b), the upper chord members 280A, the lower chord member 280B, and the lattice members 284 form a warren truss.

To link the upper chord members 280A (members 281) and the lattice members 284 to each other, as shown in FIG. 85(a), the flat end parts 284a of the lattice members 284 are made to contact with the connection pieces 281a of the members 281, and are fixed by bolts and nuts after the bolt insertion holes 284b of the flat end parts 284a (see FIG. 86) are aligned with the bolt insertion holes (not shown) of the connection pieces 281a. Furthermore, as shown in FIG. 84, among the lattice members 284, the flat end parts 284a of some members come into contact with the outsides of the connection pieces 281a, and the flat end parts 284a of other members come into contact with the insides of the connection pieces 281a, and these members are alternately arranged. In addition, as shown in FIG. 85(a), the flat end parts 284a of the lattice members 284 positioned outside the

connection pieces 281a and the flat end parts 284a of the lattice members 284 positioned inside the connection pieces 281a are fixed so as to overlap each other via the connection pieces 281a. The method for linking the lower chord member 280B (member 282) and the lattice members 284 is also the same.

Next, adjacent upper chord members 280A and 280A are linked to each other by the linking frame members 283. To link the upper chord members 280A (members 281) and the linking frame members 283 to each other, as shown in FIG. 85(a), the flat end parts 283a of the linking frame members 283 are made to contact with the connection pieces 281b of the members 281, and are fixed by bolts and nuts after the bolt insertion holes 283b of the flat end parts 283a (see FIG. 86) are aligned with the bolt insertion holes (not shown) of the connection pieces 281a.

Next, as shown in FIG. 84, the brackets 206 are supported and fixed to the bracket placing faces 281c of the upper chord members 280A.

Then, this unit is carried to a staircase installation site and installed with a predetermined slope of the staircase, and then, the treads 207 are supported and fixed to the tread supporting faces 206a of the brackets 206 and handrails, etc., are attached as appropriate, whereby the construction of the staircase is completed.

According to the staircase of the seventeenth embodiment, the linking between the upper chord members 280A and the lower chord member 280B is carried out only by linking the flat end

parts 284a of the lattice members 284 to the connection pieces 281a of the upper chord members 280 and the connection pieces 282a of the lower chord member 280B projecting in the linking directions of the lattice members 284, and this makes the assembly of the space truss structural member 280 easy.

In addition, since the connection pieces 281a and 281b of the upper chord members 280A and the connection pieces 282a of the lower chord member 280B are continued in their lengthwise directions, the degree of freedom in attaching positions of the linking frame members 283 and the lattice members 284 is high, and furthermore, it is possible to cope with changes in dimensions and shapes of the linking frame members 283 and the lattice members 284.

Furthermore, the upper chord members 280A and the lower chord member 280B are formed of each one of the long-length members 281 and 282, so that no weak axis exits among them. Namely, the upper chord members 280A and the lower chord member 280B are high in rigidity not only in the vertical direction but also in the side-to-side direction, so that a structure strong against rolling and twisting is obtained.

<Eighteenth embodiment>

The staircase according to the eighteenth embodiment of the invention is described with reference to FIG. 87 and FIG. 88. The same elements as those of the above-described embodiments are attached with the same symbols, and overlapping description thereof is omitted.

Herein, FIG. 87 is a perspective view partially omitting the staircase according to the eighteenth embodiment of the invention, and FIG. 88 is a view of the space truss structural member of the staircase according to this embodiment seen from the direction of the staircase inclination.

The staircase according to the eighteenth embodiment comprises, as shown in FIG. 87, a space truss structural member 290 inclining with the slope of the staircase, a plurality of brackets 206 disposed at each riser height, and treads 207 supported by the space truss structural member 290 via the brackets 206.

The space truss structural member 290 comprises a plate-shaped member 291, one lower chord member 290B positioned below the midpoint of this member 291, and lattice members 284 that link the member 291 and the lower chord member 290B to each other.

The member 291 is an extruded member made of an aluminum alloy, and as shown in FIG. 88, it has hollow parts 291a and 291b on the right and left, and a plate part 291b that links these hollow parts 291a and 291a, and on the hollow parts 291a, connection pieces 291c projecting toward the lower chord member 290B are formed.

Herein, the right and left hollow parts 291a and 291a correspond to the two upper chord members 290A and 290A parallel to each other, and the plate member 291b corresponds to the plate member that links the right and left upper chord members 290A and 290A. Namely, the right and left upper chord members

290A and 290A are extrusion-formed integrally with the plate member that links them.

The lower chord member 290B is formed of a member 292 having two connection pieces 292a and 292a projecting toward the upper chord members 290A as shown in FIG. 88. The member 292 is a hollow extruded member made of an aluminum alloy, and the connection pieces 292a and 292a are integrally formed when the aluminum alloy is extruded.

The method for linking the upper chord members 290A and the lattice members 284 and the method for linking the lower chord member 290B and the lattice members 284 are the same as those described in the seventeenth embodiment, so that a detailed description thereof is omitted.

According to the staircase of the eighteenth embodiment, the upper chord members 290A and 290A adjacent to each other are integrated in advance, so that the number of parts is reduced and construction of the space truss structural member 290 becomes easy.

Furthermore, in the space truss structural member, since the right and left upper chord members 290A and 290A (hollow parts 291a and 291a) are linked to each other by the plate member (plate part 291b), the shearing rigidity of the space truss structural member is very high, and since the upper chord members 290A and the lower chord member 290B are formed of each one of the long-length members 291 and 292 among which no weak axis exists, the rigidity of the space truss structural member in the side-to-side direction is high. Namely, the space truss

structural member 290 is structured to be strong against rolling and twisting.

INDUSTRIAL APPLICABILITY

According to the staircase of the present invention, the treads are supported by the truss structural members or the space truss structural member that have a lightweight structure with a sense of lightness in weight and create no sense of oppression even if the staircase is installed indoors. Furthermore, the lightness in weight of the staircase facilitates its handling during construction, as compared with the conventional staircases composed of heavy members such as channel steel or I-shaped steel, thereby improving constructing efficiency.

In addition, not requiring special tools or welding facilitates the constructing of the staircase. Furthermore, the members composing the truss structural members or the space truss structural member are small in number and can be commonly used even when the installing requirements of the staircase are different. This feature is suitable for mass production, providing high producing efficiency.